PROBESCOPE

211 ROBBINS LANE, SYOSSET, L.I., NEW YORK

INSTRUCTION MANUAL

SPECTRUM ANALYZER

MODEL MD-500 SPECIAL

for Sylvania Electronic Systems

WITH ADDENDUM

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_11220

ADDENDUM

The Model MD-500 has been converted from a Model MD500-E with the following changes to Sylvania specification per PO MV23374:

The variable sweep width has been changed from 0-100 MC to 0-15 MC, and all references to 0-100 MC in the manual should now read 0-15 MC.

In addition, the variable sweep has been changed to 0.1 - 30 sweeps per second in two switch positions 0.1 to 3 and 1-30.

The input attenuator and mixer jack has been removed, and the instrument has been revised to operate at 455 MC instead of 500 MC. All these changes were made to specification, and references to attenuator and external oscillator input should be eliminated, and 500 MC references in the manual should be 455 MC. All other specifications in the manual will hold.

The standard MD500 has been modified to provide a 10 volt, low impedance source of Vertical and Horizontal output signals by the addition of the dual cathode follower V305.

Section A of V305 provides a positive going sawtooth of 10 volts amplitude into an external 1K ohm load resistor connected to the Horizontal output jack. This sawtooth is direct coupled to the output and centered about zero volts d.c. The output impedance of this cathode vollower is comprised of R371 (750 ohms) plus the output impedance of V305A (250 ohms).

Section A of V305 also provides a negative going pulse during the relatively constant retrace period by means of C310. C310, in conjunction with an external 1K ohm load resistor differentiates the positive going sawtooth at the cathode (Pin 3) of V305 producing the desired output at the retrace output jack.

Section B of V305 provides a Vertical output signal proportional to the detected signal. This signal is obtained directly from the detector plate circuit (V208) and filtered to remove the 100 MC I.F. frequency by means of R372 and C311. The filtered signal is applied to the vertical output jack through cathode follower V305B, whose source impedance is approximately 250 ohms. Direct coupling is used in this circuit to provide a signal proportional to the C.R.T. deflection during slow, narrow scans of frequencies that essentially are d.c. signals.

ADDENDUM

The Model MO-500 has been converted from a Model MO500-C with the following changes to Sylvania specification per PO MV23574:

The variable sweep width has been changed from 0-100 KC to 0-15 KC, and all references to 0-100 KC in the manual should now read 0-15 KC.

In addition, the variable sweep has been changed to 0.1 - 30 sweeps per second in two switch positions 0.1 to 3 and 1-30.

The input attenuator and mixer jack has been removed, and the instrument has been revised to operate at 455 KC instead of 500 KC. All these changes were made to specification, and references to attenuator and external oscillator input should be eliminated, and 500 KC references in the manual should be 455 KC. All other specifications in the manual will hold.

The standard MO500 has been modified to provide a 10 volt, low impedance source of Vertical and Horizontal output signals by the addition of the dual cathode follower V30B.

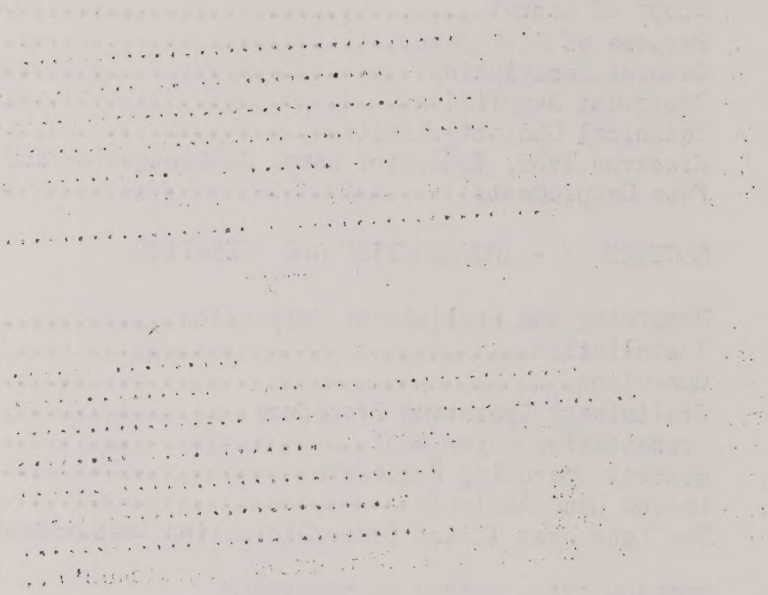
Section A of V30B provides a positive going sawtooth of 10 volts amplitude into an external 1K ohm load resistor connected to the Horizontal output jack. This sawtooth is direct coupled to the output and centered about zero volts d.c. The output impedance of this cathode follower is comprised of R37I (750 ohms) plus the output impedance of V30A (250 ohms).

Section A of V30B also provides a negative going pulse during the relatively constant retrace period by means of C310. C310, in conjunction with an external 1K ohm load resistor differentiates the positive going sawtooth at the cathode (pin 3) of V30B producing the desired output at the retrace output jack.

Section B of V30B provides a Vertical output signal proportional to the detected signal. This signal is obtained directly from the detector plate circuit (V20B) and filtered to remove the 100 KC I.F. frequency by means of R37Z and C311. The filtered signal is applied to the vertical output jack through cathode follower V30B, whose source impedance is approximately 250 ohms. Direct coupling is used in this circuit to provide a signal proportional to the C.R.T. deflection during slow, narrow scans of frequencies that essentially are d.c. signals.

TABLE OF CONTENTS

Paragraph	Title	Page
	SECTION I - INTRODUCTION	
1-1	Scope of Manual	1
1-3	Purpose of Equipment	1
1-5	General Description	1
1-9	Equipment Supplied	2
1-11	Technical Characteristics	3
1-13	Electron Tube, Indicator Lamp, Semiconductor and Fuse Complements	4
	SECTION II - INSTALLATION AND OPERATION	
2-1	Unpacking and Preliminary Inspection	7
2-3	Installation	7
2-7	Operation	10
2-8	Preliminary Operating Procedure	10
2-9	Presentation Adjustment	11
2-10	General Operating Procedure	12
2-11	Narrow Band Analysis	13
2-13	Two Tone Test (Third Order Distortion Measurement)	15
	SECTION III - THEORY OF OPERATION	
3-1	Introduction	16
3-3	Simplified Block Diagram Analysis	16
3-7	Detailed Circuit Analysis	16
3-9	First Mixer V101	16
3-10	R-f Amplifier V102	17
3-11	Second Mixer V103	17
3-12	I-f Circuits	17
3-18	Detector V203	18
3-21	Vertical Deflection Amplifier V304	18
3-23	Local Oscillator and Reactance Tube V106	18
3-25	Sawtooth Generator V301	18
3-26	Cathode Follower V302	18
3-27	Frequency Discriminator V104 and V105	19
3-29	Horizontal Deflection Amplifier V303	19
3-32	Marker Oscillator V108	19
3-34	Cathode Ray Tube V401	20
3-36	Power Supplies	20



Paragraph | Page

SECTION IV - MAINTENANCE

4-1	General	21
4-3	Test Equipment	21
4-5	Minimum Performance Standards	21
4-7	Circuit Trouble Shooting	25
4-11	System Trouble Shooting	31
4-15	Adjustment and Alignment Instructions	36
4-17	Adjustments	36
4-18	Filament Adjust	36
4-19	B+ Adjust	36
4-20	DB Shape Control R263 & DB Range Control 269	36
4-21	Gain Calibrate Control R241	36
4-22	Alignment Procedures	37
4-23	I-F Circuit	37
4-24	Crystal Filter V201, V203 and V204	38
4-25	Sweep Circuit	40
4-26	Local Oscillator V106	40
4-27	Discriminator	41
4-28	Removal & Replacement Instructions	42
4-30	Cathode Ray Tube	42
4-31	Edge Lighting Lamps	43
4-32	Schematic	43
4-34	Voltage and Resistance Charts	43
4-36	Lubrication	43

SECTION I

INTRODUCTION

1-1. SCOPE OF MANUAL

1-2. This manual contains instructions for the installation, operation, and maintenance of the Probescope Spectrum Analyzer, Model MD500E. The Model MD500E is designed and manufactured by Probescope Company, Inc., Syosset, Long Island, New York.

1-3. PURPOSE OF EQUIPMENT

1-4. The Spectrum Analyzer, Model MD500E, is a precision instrument for presenting the spectral display of r-f signal energy. The spectral display appears on the screen of a long-persistence cathode ray tube with the frequency of the applied signal being displayed on the horizontal axis, while the amplitude of the signal is displayed on the vertical axis. Some of the specific uses of the Model MD500E are:

a. Single side band analysis of r-f signals.
b. Noise and vibration analysis.
c. Harmonic and distortion study of amplifiers, modulators, and oscillators.
d. Pulsed r-f signal investigations.
e. Analyze AM, FM, and SSB transmitters.
f. Power line susceptability testing.
g. Assembly line checking and maintenance of equipment.
h. Radio interference measurements.

1-5. GENERAL DESCRIPTION

1-6. The Probescope Model MD500E Spectrum Analyzer is a versatile precision instrument that combines high accuracy, simplicity of operation, ease of maintenance and portability. The equipment is a highly sensitive superheterodyne receiver, whose output can be linearly or logarithmically displayed on a calibrated cathode ray tube. The Model MD500E has two modes of operations: Input signals between 450 and 550 kc can be directly applied for analysis. For signal analysis above this frequency range, an external local oscillator signal, 500-kc above the signal to be analyzed must be simultaneously applied to the equipment.

1-7. With a 1.5 volt rms external local oscillator input level, a 2 millivolt or smaller signal input level produces a full-scale log deflection on the crt screen. Fixed and variable sweep widths are provided for preliminary and detailed analysis of signals. The sweep width determines the frequency range above and below the center frequency. A 10-kc, 2-kc, 500-cps, and 150-cps fixed as well as a 0 to 2-kc and 0 to 100-kc variable sweep widths are provided. All are AFC stabilized except for the fixed 10-kc and variable 0 to 100-kc sweep widths.

1-8. The Model MD500E essentially consists of an input mixer, r-f amplifier, second mixer, crystal filters, i-f amplifiers, detector, frequency discriminator, swept local oscillator, sawtooth generator, and vertical and horizontal deflection amplifiers for the cathode ray tube display. The equipment is furnished in a cabinet for bench or cart use, or can be removed from its cabinet for standard rack mounting.

1-9. EQUIPMENT SUPPLIED

1-10. Table 1-1 lists the equipment which comprise the Model MD500E.

Component	Model or Part No.	Over-all Dimensions (in.)	Weight (lbs.)
Spectrum Analyzer	MD500E	Cabinet--15½" h. x 22" w. x 18" deep Rack Mount--12¼" h. x 19" w. x 17½" deep	Cabinet--85 lbs. Rack Mount--55 lbs.
Alignment Tool			
Spare Fuses			
Handbook			

Table 1-1. Equipment Supplied.

1-11. TECHNICAL CHARACTERISTICS.

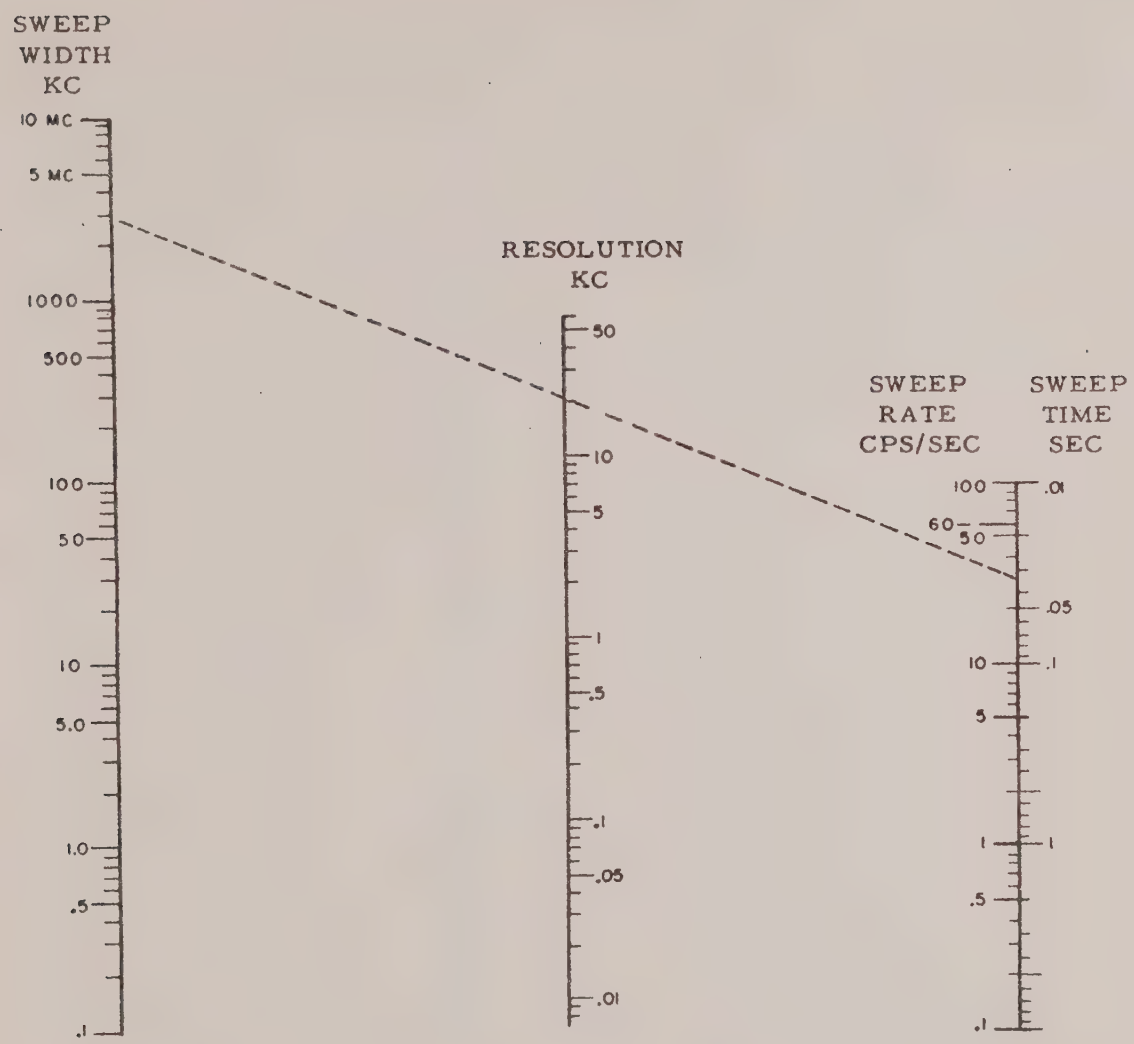
1-12. The technical characteristics of the Model MD500E are listed below. Unless otherwise stated, all values are nominal.

Input Center Frequency	500 kc
Input Center Freq. Bandpass	450 to 550 kc, ±0.5 db
Minimum Direct Sensitivity for Full Scale Linear Deflection	20 microvolts
Minimum Conversion Sensitivity for Full Scale Log	2 millivolts
Freq. Range (with External Local Oscillator)	450 kc to 50 mc, useable up to 1000 mc.
External Local Oscillator Requirements:	
Frequency Range	500 kc above signal to be analyzed
Voltage Level	1.5 volts rms
Sweep Widths	0 to 100 kc, variable 0 to 2 kc, variable (AFC) 10 kc, fixed 2 kc, fixed (AFC) 500 cps, fixed (AFC) 150 cps, fixed (AFC)
Sweep Width Accuracy	±10 percent
Sweep Rate	1 cps, fixed 0.1 cps, fixed 1 to 30 cps, variable
Resolution	10 cps to 2.7 kc, adjustable (See figure 1-2.)
Amplitude Scale	RMS and DB Log
Dynamic Range	65 db
Input Impedance	50 ohms
Internal Marker	500 kc (crystal controlled)
External Modulation Input Requirements	5 volts rms, nominal
Image Rejection	Better than 130 to 1 at input center frequency

Two Tone Test	Discern intermodulation products (odd order) 65 db below test sideband signal level
Spectral Display	Signal amplitude on vertical axis (linear or log) versus frequency on horizontal axis.
Cathode Ray Tube	5ADP7 (long-persistence with edge lighting and camera mount bezel.
Signal Outputs	
Vertical	1V P-P 130k nominal impedance
Horizontal	1V P-P 33k nominal impedance
Sync	Neg. 60V pulse 470 uufd.
Power Requirements	115V±10% AC, 50-60 cps single phase, 125 watts.

1-13. ELECTRON TUBE, INDICATOR LAMP, SEMICONDUCTOR AND FUSE COMPLEMENTS.

1-14. Tables 1-2 through 1-4 list the electron tube and indicator lamps, semiconductor, and fuse complements, respectively.



NOTE

Portions of this nomograph which are usable for the analyzer covered by this Instruction Manual are listed under maximum sweep width, sweep rates and resolution in section I – ELECTRICAL CHARACTERISTICS.

Figure I –2. Resolution Nomograph.

Reference Symbol Designation	Type	Function
V101	12At7	Mixer
V102	12AT7	R-f Amplifier
V103	12AT7	Second Mixer
V104	6BH6	Discriminator Amplifier
V105	6AL5	Discrimator Rectifier
V106	12AT7	A: Reactance Tube B: Local Oscillator
V108	6AB4	Marker Oscillator
V201, V203, V204	6AB4	Crystal Filters
V202	6BH6	I-f Amplifier
V205, V206, V207	12AU6	I-f Amplifiers
V208	604	Detector
V301	5696	Sawtooth Generator
V302	12AT7	Cathode Follower
V303, V304	12AX7	Horizontal and Vertical Deflection Amplifiers
V401	5ADP7	Cathode Ray Tube
V503	6AS7	Voltage Regulator Control
V504	12AU6	Voltage Control DC Amplifier
V505	5651	Voltage Regulator
V506	OB2	Voltage Regulator
DS501 thru DS505		Indicator Lamps

Table 1-2. Electron Tube and Indicator Lamp Complement

Reference Symbol Designation	Type	Function
Q501	2N277	Voltage Regulator Control
CR501, CR502	1N248	Voltage Rectifiers
CR503 thru CR510		High Voltage Rectifiers
CR511 thru CR513		Voltage Rectifiers
ZR503	1N2976R	Voltage Reference (Zener)

Table 1-3. Semiconductor Complement

Reference Symbol Designation	Type	Rating
F501, F502, F504, F505		3 Amperes

Table 1-4. Fuse Complement

SECTION II

INSTALLATION AND OPERATION

2-1. UNPACKING AND PRELIMINARY INSPECTION

2-2. Unpacking equipment from its carrying case observing normal precautions for a precision instrument. Before operating the Model MD500E, inspect for possible damage during shipment. Check that the equipment is complete as listed in table 1-1 or against the packing slip. After the equipment has been checked for completeness, inspect it as follows:

a. Examine handles for tightness.
b. Operate all front panel controls which should turn freely, be tight on their shafts, and lack of binding.
c. All tubes, crystals, and other plug-in parts are well seated in their sockets.

2-3. INSTALLATION

2-4. The equipment can be placed in any suitable working area where normal lighting and ventilation are present. A nominal 115 volts, 60 cps, single phase power source is required for operation of the equipment.

2-5. The Model MD500E is furnished mounted in a cabinet for bench or cart use. It can be removed from its cabinet for standard rack mounting. Figures 2-1 and 2-2 are outline drawings of the Spectrum Analyzer to assist the operator in planning the equipment's installation.

2-6. The operating controls and connectors located on the front panel of the equipment are listed in table 2-1 and shown in figure 2-3. It is important to know the function of each control before operating the equipment.

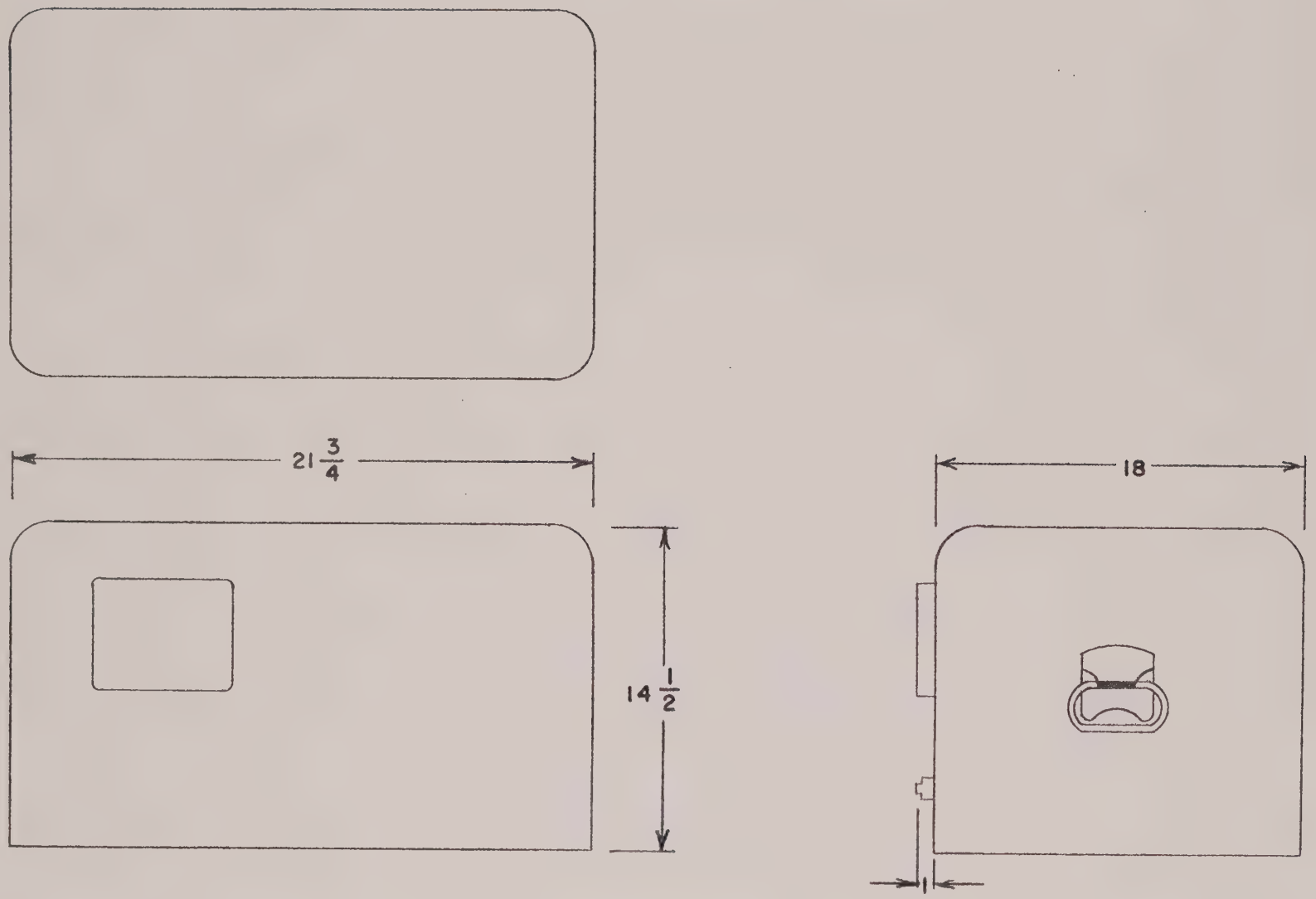


FIGURE 2 1 SPECTRUM ANALYZER MODEL MD 500E CABINET MODEL
DIMENSIONAL DRAWING

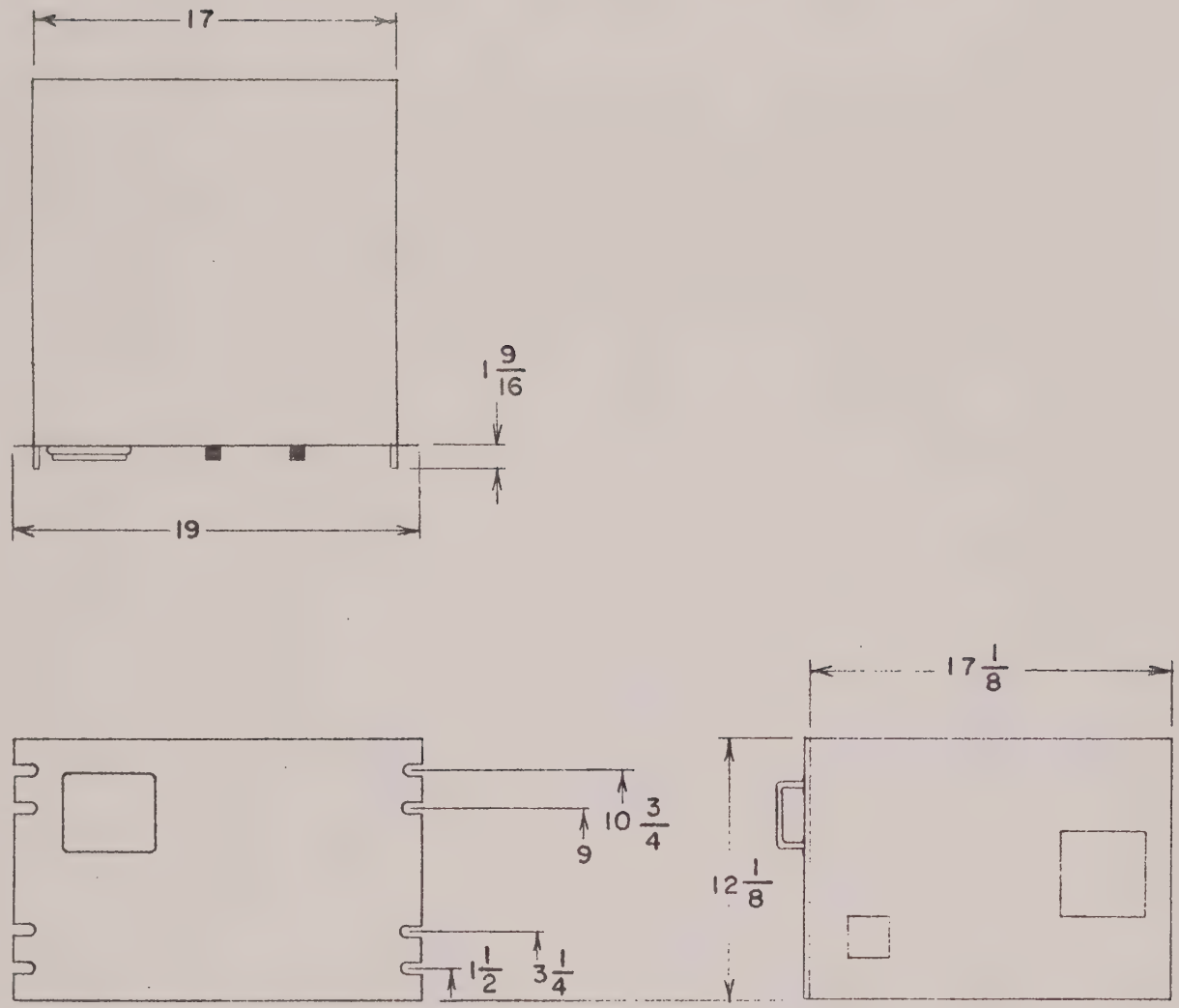


FIGURE 2-2. SPECTRUM ANALYZER, MODEL MD 500E, RACK MOUNT MODEL, DIMENSIONAL DRAWING

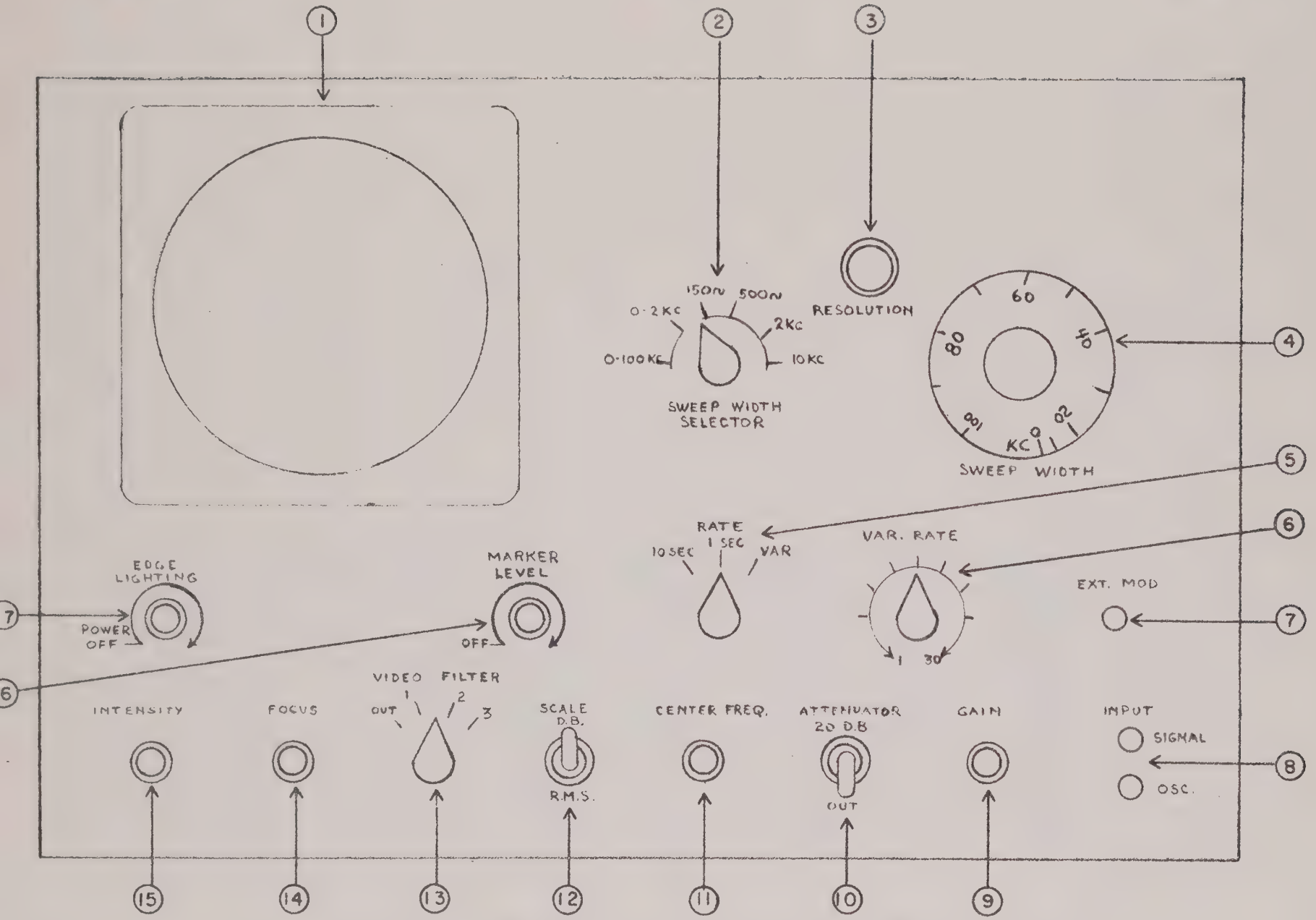


FIGURE 2-3 SPECTRUM ANALYZER, MODEL MD500E

Figure 2-3 Index No.	Front Panel Designation	Function
1	Cathode Ray Tube	Provides input signal display; frequency on horizontal axis, amplitude (linear or log) on vertical axis.
2	SWEEP WIDTH SELECTOR	This control provides a choice of four pre-set sweep widths of 150cps, 500cps, 2 kc, and 10 kc; and two variable sweep widths of 0 to 2 kc and 0 to 100 kc.
3	RESOLUTION	Rotation of this control varies the i-f bandwidth for fine analysis of signals. See figure 1-2 for relationship of resolution versus sweep width.
4	SWEEP WIDTH	This control varies the sweep width between 0 to 2 kc or 0 to 100 kc (depending upon the setting of the SWEEP WIDTH SELECTOR).
5	RATE	This control provides scanning rates of 0.1 cps (10 SEC) and 1 cps (1 SEC) and a variable (VAR) scanning rate between 1 and 30 cps (determined by setting of the VAR RATE control).
6	VAR RATE	With the RATE control in the VAR position, rotation of the VAR RATE control provides a scanning rate between 1 to 30 cps.
7	EXT MOD. INPUT	This jack allows an external signal to be superimposed on the 500 kc marker.
8	INPUT	The INPUT receptacles are two BNC connectors. The signal to be analyzed is connected to the SIGNAL receptacle and the local oscillator signal is connected to the OSC. receptacle.

Table 2-1. Operating Controls and Connectors (Sheet 1 of 2)

Figure 2-3 Index No.	Front Panel Designation	Function
9	GAIN	This control adjusts the height of the vertical display on the crt screen. The GAIN control should be operated at the max. setting consistent with signal display on the crt.
10	ATTENUATOR	This toggle in the 20 DB position inserts 20 db of attenuation in the i-f circuit. In the OUT position, the full 65 db dynamic range of the Model MD500E can be used.
11	CENTER FREQUENCY	This control nominally adjusts the 600 kc swept local oscillator frequency to center the signal display on the crt screen.
12	SCALE	This toggle switch permits choice of vertical screen calibration: RMS - Dots appearing along left edge indicate linear rms amplitude as calibrated. DB - Horizontal lines on screen indicate 5 db increments from 0 to -40 as calibrated along right edge.
13	VIDEO FILTER	The VIDEO FILTER control is used to eliminate beat interference between two adjacent signals. Proper choice of filter position is indicated by no change in signal amplitude.
14	FOCUS	This control adjusts the sharpness of the trace.
15	INTENSITY	This control adjusts the brilliance of the trace.
16	MARKER LEVEL	Clockwise rotation of this control applies a 500 kc calibrated marker signal, (crystal controlled)
17	EDGE LIGHTING	Clockwise rotation of this control turns on the equipment and varies the crt edge lighting.

Table 2-1. Operating Controls and Connectors (Sheet 2 of 2)

2-7. OPERATION

2-8. PRELIMINARY OPERATING PROCEDURE. The procedure given below is to be followed prior to making specific measurements with the Model MD50CE:

(1) Connect a nominal 115 volts ac, 60 cps, single phase power source to the equipment.

(2) Set the front panel controls to:

SWEEP WIDTH SELECTOR	-	0 - 100 MC
SWEEP WIDTH	-	100 MC
RESOLUTION	-	Fully clockwise
RATE	-	VAR
VAR RATE	-	30 cps
ATTENUATOR	-	OUT
SCALE	-	RMS
VIDEO FILTER	-	OUT

(3) Turn EDGE LIGHTING (power off) control clockwise until the crt graticule is illuminated to desired birghtness.

(4) Within a short time, a dot will appear and begin moving across the screen. This dot is the baseline trace.

(5) Adjust INTENSITY and FOCUS controls for proper brilliance and sharpness of trace.

(6) Turn MARKER LEVEL control clockwise until a full scale marker pip is displayed on the crt screen.

(7) Adjust CENTER FREQ. control until marker pip is at center of crt screen.

(8) Adjust SWEEP WIDTH control counter-clockwise and simultaneously adjust CENTER FREQ. control to maintain marker pip at center of crt screen.

(9) Continue to adjust SWEEP WIDTH control counter-clockwise until maximum vertical baseline rise is observed. Adjust CENTER FREQ. control as required The MARKER LEVEL control may require re-setting to maintain baseline on crt screen.

(10) Set VAR RATE CONTROL to 1 second. Adjust SWEEP WIDTH control clockwise and note that marker pip is at center of crt screen. If not, unlock and adjust HOR. POS. control R325 to position marker pip at center of crt screen. Relock control R325.

(11) Reset RATE control to 1 second, and note that marker pip is at center of crt screen.

(12) Set ATTENUATOR switch to 20 DB.

(13) Adjust MARKER LEVEL control for full scale marker pip.

(14) Set SCALE switch to DB.

(15) Note that marker pip is at -20 DB graduation marking.

(16) Set ATTENUATOR to OUT.

(17) Note that marker pip is at 0 DB graduation marking.

(18) The equipment is now ready for use.

NOTE

The signal presentation controls for position and uniformity of trace have been factory set for optimum viewing. If it is required to adjust the signal presentation, refer to paragraph 2-10 for the procedure.

2-9. PRESENTATION ADJUSTMENT

2-10. The controls listed in table 2-2 have been factory set for optimum viewing of the signal display. If it is required to adjust the signal display for position or uniformity, refer to table 2-2 and adjust the appropriate control as required.

CONTROL	FUNCTION
Astigmatism (R401)	This control is used to provide uniform focus throughout the trace.
Vert. Pos. (R235)	This control is used to adjust the vertical position of the trace. Clockwise rotation raises the trace.
Horiz. Pos. (R325)	This control is used to adjust the horizontal position of the trace. Clockwise rotation shifts the trace to the right.
Line Size (R320)	This control varies the size of the spot excursion. Correct line size is 3-3/4 inches. When varying line size, adjustment of horizontal positioning may be necessary.

Table 2-2. Presentation Controls.

2-11. GENERAL OPERATING PROCEDURE

2-12. To observe the spectral characteristics of signals for: Voltage measurements; frequency component identification; harmonic investigations, modulation characteristics; etc., the following general techniques should be followed:

(1) For analysis of signals above the nominal input center frequency of 500 kc, an external local oscillator must be employed. The test signal to be analyzed is connected to the SIGNAL INPUT connector and the local oscillator connected to the OSC. INPUT connector.

(2) By use of the GAIN control and 20 db attenuator, relative voltage measurements can be made of applied signals. Refer to table 2-3 for external local oscillator signal levels which produce full scale test signal deflections. To observe signals of comparible amplitude, the SCALE SELECTOR should be set to RMS. The RMS scale of the crt screen is calibrated into ten divisions. Calibrated dots on the left side of the screen indicate linear rms amplitude. When simultaneous examination of signals of wide divergence (greater than 20 db but less than 40 db) of amplitude is desired, the DB setting of the SCALE SELECTOR permits both signals to be seen in this position, the calibrated range is from 0 to -40 db in 5 db divisions, as indicated by horizontal lines corresponding to the calibration appearing along the right side of the screen.

(3) It is recommended that the frequency of the external local oscillator signal applied to the OSC. INPUT connector always be 500 kc above the test signal frequency. When the local oscillator signal is aobve the test signal frequency, the signal pip wi move from left (-) to right (+) as the local oscillator signal frequency is increased. Signals on the left (-) side are higher in frequency than the center signal frequency while those on the right (+) side are lower.

(4) For frequency component identification of signals, the following expression should be used:

Test Signal Frequency	=	Local Oscillator Frequency	Sweep Width ± Screen Calibration	±500 kc

EXAMPLE: The following typical conditions exist -

(a) SWEEP WIDTH SELECTOR set to 2 KC.
(b) External local oscillator signal frequency is 8,100 kc.
(c) Signal pip to be identified appears directly over ±20% screen calibrated marking.
(d) Local oscillator signal is 500 kc above frequency of test signal.
(e) With the SWEEP WIDTH SELECTOR set to 2 KC, each screen calibration marking indicates 0.2 kc frequency width.
(f) Using the above expression, the test signal frequency is found to be:

Test Signal Frequency	=	8,100 kc	+	0.2 kc	- 500 kc	=	7,600.2 kc

External Local Oscillator Level (Volts rms) minimum	Test Signal Level (Volts rms) maximum	SCALE switch setting	ATTENUATOR switch setting
1.5	200 u volts	RMS	OUT
1.5	2 millivolts	RMS	20 D.B.
1.5	2 millivolts	D.B.	OUT
1.5	20 millivolts	D.B.	20 D.B.

Table 2-3. Local Oscillator Signal Level for Full Scale Test Signal Deflection

2-13. NARROW BAND ANALYSIS

2-14. The Model MD500E has been designed specifically for applications demanding exceptionally high resolution capabilities. Resolution, or the ability to separate individual signals, is dependent upon two factors; The rate of frequency scan (product of sweep width and sweep rate) and the i-f bandwidth of the instrument. Resolution sharpens as both the scanning rate and i-f bandwidth decrease. The scanning rate can be diminished by increasing the scanning period or conversely by decreasing the sweep (spectrum) width. The MD500E employs both methods for highly flexible operations. The following procedure should be used for analysis of narrow band signals:

(1) Follow the procedure given in paragraph 2-8, for starting up the equipment.

(2) Set the SWEEP WIDTH SELECTOR control for desired spectrum width. The smaller the spectrum width, the greater will be the resolution capability of the equipment. If the variable sweep width is selected, adjust the SWEEP WIDTH control as required.

(3) Set the RESOLTUION control fully clockwise. If the signals cannot be resolved, a slower sweep rate will be required. Set the RATE control to VAR. Adjust the VAR RATE and RESOLUTION controls as required.

(4) Steps (2) and (3) above may have to be repeated in order to optimize control settings.

(5) Figure 2-4 illustrates optimum resolution for a continuous wave signal. Optimum resolution can be recognized by the nature of the ringing pulses appearing on the trailing edge of the signal pip as optimum resolution is approached. Illustrations (a) through (f) of figure 2-4 indicate progressive variations in pip width as the RESOLUTION control is rotated counterclockwise. Illustration (d) shows optimum resolution with maximum extent of ringing.

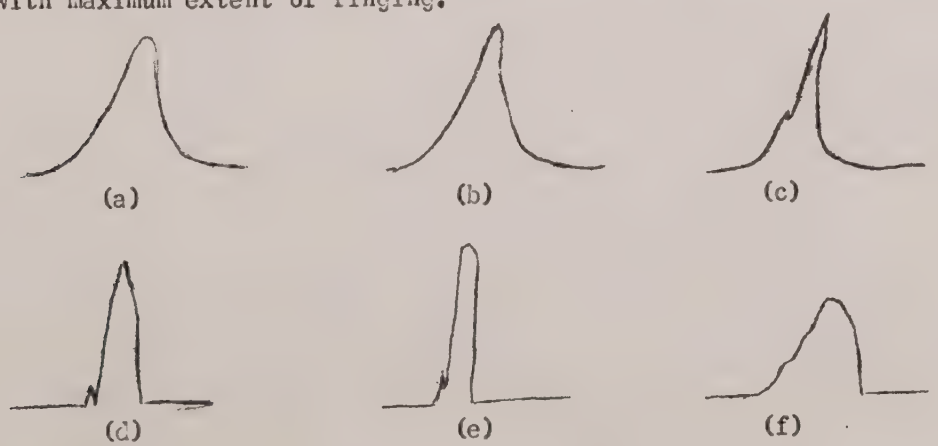


Figure 2-4. Optimum Resolution for CW Signal

2-15. TWO TONE TEST. (THIRD ORDER DISTORTION MEASUREMENT.)

2-16. In measuring third-order distortion in single sideband (SSB) transmitters, the transmitter is modulated by two distortion-free audio tones of equal amplitude, with a difference frequency of the order of 1 kc. The r-f output of the SSB transmitter will therefore be two signals separated by the audio difference frequency. The presence of third-order distortion in the SSB transmitter will be indicated by spurious signals higher and lower in frequency than the two r-f carriers by an amount equal to the difference frequency. The following procedure should be used for two tone testing:

(1) The external local oscillator signal amplitude should be at least 1.5 volts, but no more than 2 volt rms.

(2) Follow the normal operating procedure to display the two r-f signals on the crt screen. Use a sweep width at least three times the separation between the two r-f signals.

(3) Set the SCALE switch to D.B.

(4) Set the ATTENUATOR switch to 20 D.B.

(5) Adjust the GAIN control for full scale signal pips.

(6) Set the ATTENUATOR switch to OUT. The crt display now shows signals from -20 to -60 db relative to the two r-f input signals. The amplitude of third-order distortion pips may be read from the LOG scale calibration.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The Model MD500E is a superheterodyne receiver whose detected output is displayed on a cathode ray tube. It displays the frequency of the applied signal along the horizontal axis while the amplitude of the signal is displayed linearly or logarithmically on the vertical axis. This section of the manual discusses the theory of operation for the Model MD500E. It is divided into two parts, a simplified block diagram analysis and a detailed circuit analysis.

3-3. SIMPLIFIED BLOCK DIAGRAM ANALYSIS
(See figure 3-1.)

3-4. The simplified block diagram analysis details only the basic elements that are necessary to explain the operation of the analyzer. The following description traces a signal through this simplified network.

3-5. The Model MD500E has two modes of operation. Input signals between 450 and 550 kc can be applied directly for analysis. For signal analysis above this frequency range, an external local oscillator signal, 500 kc above the signal to be analyzed must be simultaneously applied to the equipment.

3-6. An external test signal is heterodyned with an external local oscillator signal. The resultant difference frequency of 500 kc is filtered and amplified. It is then mixed with a swept local oscillator signal centered at 600 kc. The resultant 100 kc i-f difference frequency output is then amplified and detected. The detected signal is further amplified to drive the vertical deflection plates of a cathode ray tube. At the same time, a synchronizing sawtooth signal which sweep the local oscillator also is applied to the horizontal deflection plates of the cathode ray tube, so that movement of the spot across the screen is proportional to the incoming detected signal.

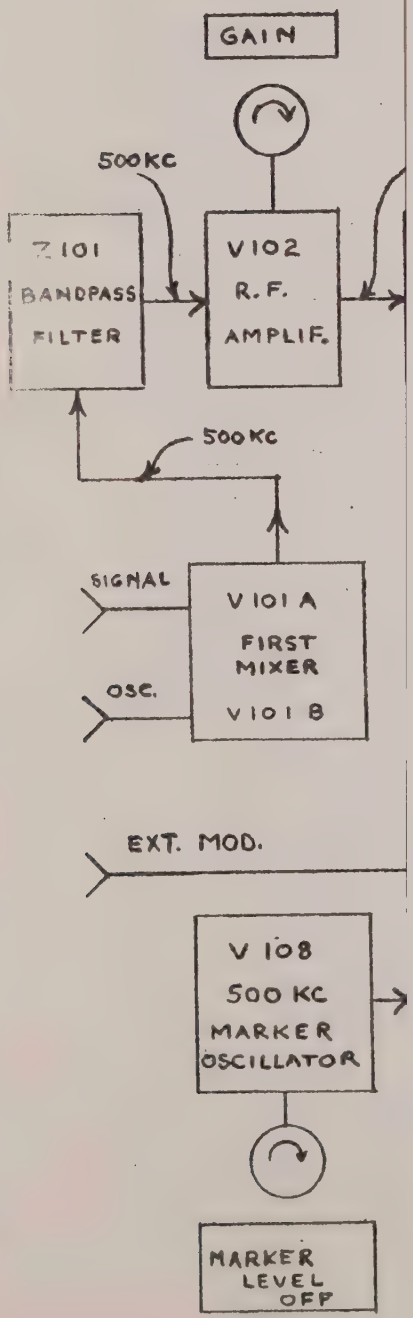
3-7. DETAILED CIRCUIT ANALYSIS
(See figure 3-1.)

3-8. The circuit stages shown in figure 3-1 essentially comprise the Model MD500E Spectrum Analyzer. The following paragraphs detail the operation of each stage.

3-9. FIRST MIXER V101. For analyzing signals between 450 and 550 kc, no external local oscillator is required. For analyzing signals above this frequency range, tube V101 serves as an aperiodic mixer (with a suitable local oscillator. The products of this mixing stage are applied to bandpass filter designed to provide a flat bandpass from 450 to 550 kc with a sharp cutoff above 550 kc to reduce image responses.

3-10. R-F AMPLIFIER V102. The nominal kc output of filter Z10 is coupled to cascode r-f amplifier V102. GAIN control R in the cathode circuit of V102 allows up to 20 db of attenuation. The output of the r-f amplifier is coupled to second mixer V103.

3-11. SECOND MIXER V103. Tube V103 heterodynes the amplified 500-kc signal with a swept local oscillator signal (centered at 600 kc) and applies the



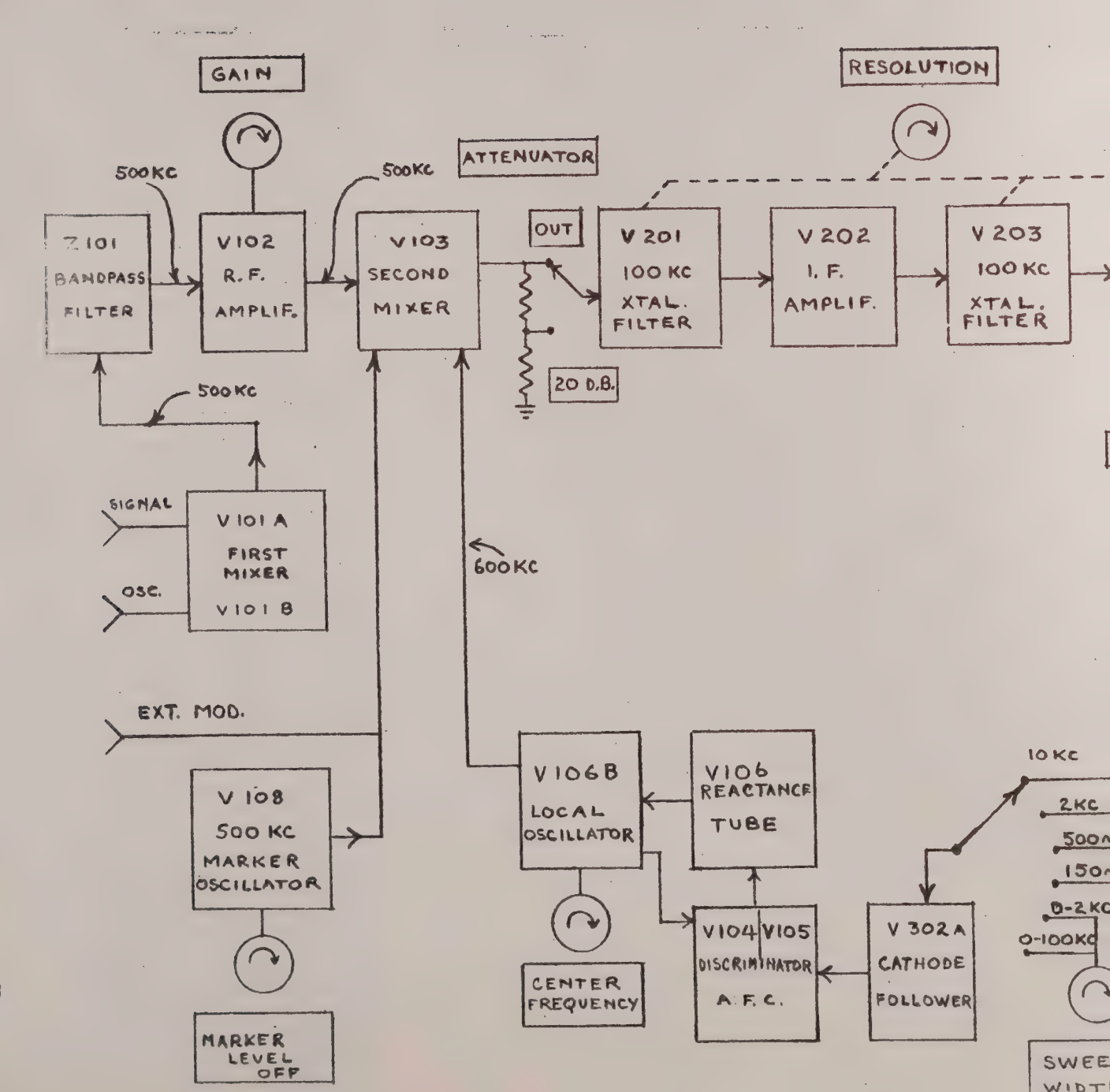
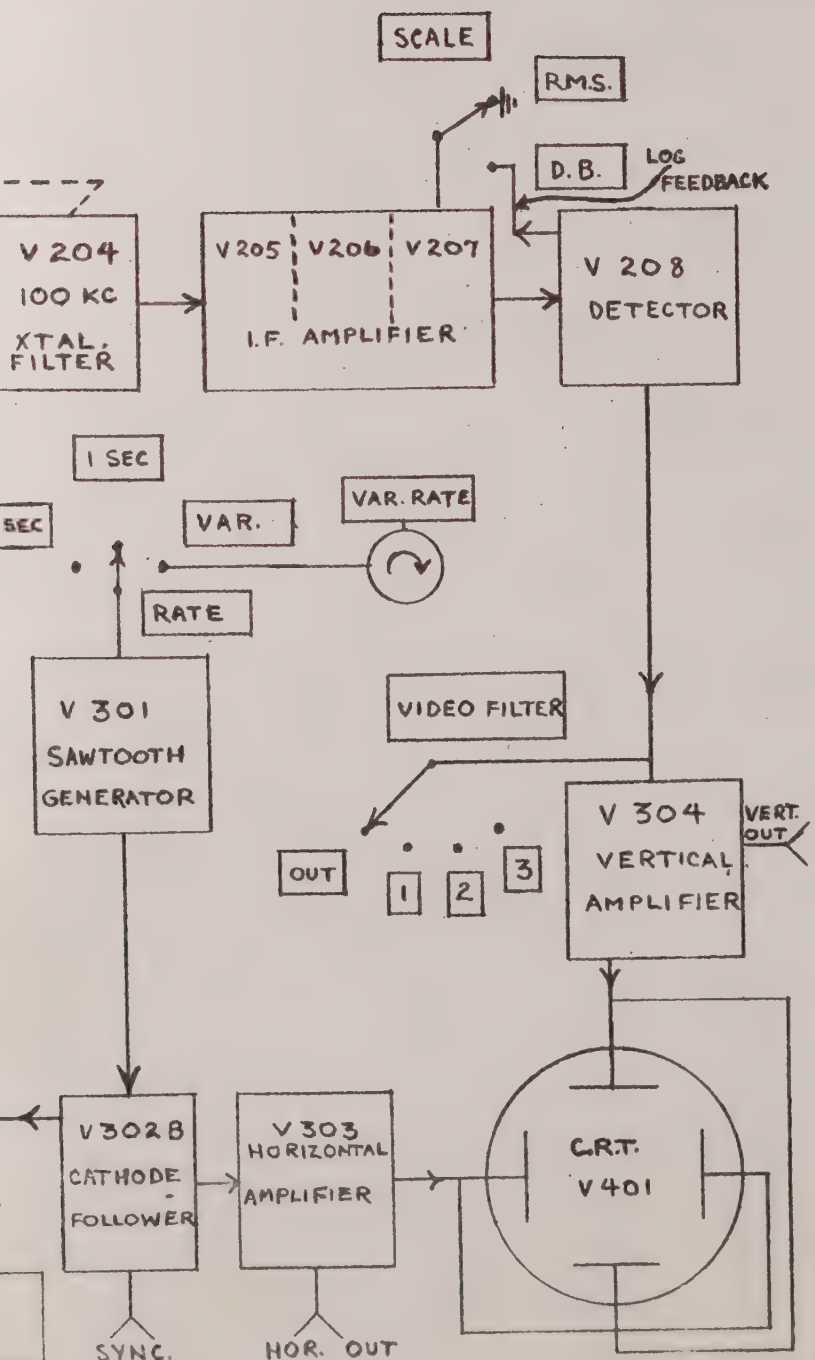


FIGURE 3-1 SIMPLIFIED BLOCK DIAGRAM ANALYSIS


SCALE
R.M.S.
D.B.
LOG FEEDBACK
V 204
100 KC
XTAL. FILTER
V205
V206
V207
I.F. AMPLIFIER
V 208
DETECTOR
1 SEC
SEC
VAR.
VAR. RATE
RATE
V 301
SAWTOOTH GENERATOR
VIDEO FILTER
OUT
1
2
3
V 304
VERTICAL AMPLIFIER
VERT. OUT
V302B
CATHODE FOLLOWER
V 303
HORIZONTAL AMPLIFIER
C.R.T.
V 401
SYNC.
HOR. OUT

3-10. R-F AMPLIFIER V102. The nominal kc output of filter Z10 is coupled to cascode r-f amplifier V102. GAIN control R in the cathode circuit of V102 allows up to 20 db of attenuation. The output of the r-f amplifier is coupled to second mixer V103.

3-11. SECOND MIXER V103. Tube V103 heterodynes the amplified 500-kc signal with a swept local oscillator signal (centered at 600 kc) and applies the resultant difference frequency of 100 kc to the i-f circuits, via transformer Z102 and ATTENUATOR switch S201.

3-12. I-F CIRCUITS. The 100 kc i-f frequency is applied through ATTENUATOR switch S201 to the grid of the first crystal filter amplifier V201. The selectivity of the Spectrum analyzer is regulated by varying the bandwidth of the three 100 kc crystal filters Y201, Y202, and Y203 which insures optimum resolution at all input frequencies.

3-13. The signal input from the cathode of V201 is fed through capacitor C203 and the 100 kc crystal filter Y201 to the grid of first i-f amplifier V202. Simultaneously, the output from the plate of V201 (amplified i-f signal) is coupled through neutralizing C202 (to neutralize crystal holder capacity) to the grid of V202. A load tank circuit L201 and L202 acts as a resistance in series with crystal Y201 to control the crystal filter bandwidth. RESOLUTION control R206 is across the tank circuit and varies the series resistance and bandwidth.

3-14. Tubes V203 and V204 perform in an identical manner as tube V201. The output from tube V204 is applied to i-f amplifier V205. The signal is amplified and applied to the grid of i-f amplifier V206 through i-f transformer Z201. V206 also amplifies this signal; however, the amplification of this stage is tracked the the RESOLUTION control. Gain tracking control R226 is automatically adjusted for minimum resistance when the RESOLUTION control is tuned to minimum with a resultant constant over-all gain for all bandwidth settings. Gain compensation control R225 sets the proper amplification range over which the gain tracking control will operate.

3-15. The output of i-f amplifier V206 is coupled through i-f transformer Z202 to the grid of i-f amplifier V207. The final i-f amplifier V207 has two modes of operation. In the SCALE-RMS position, V207 acts as a linear amplifier, in the DB position, V207 has an amplification curve that approximates a logarithmic characteristic.

3-16. When the SCALE switch S202 is in the RMS position, the frid of V207 is grounded through the secondary of transformer Z202 and R232. This causes V207 to amplify the i-f signal in a linear manner.

3-17. With the SCALE switch in the DB position, a portion of the detected signal from V208 is applied through R248, filtering network R242, R232, and C219, to the grid of V207. At the same time, the screen voltage of V207 is changed to set for proper gain characteristics. Controls R243 and R241 are set to shape the logarithmic output of V207. The output of V207 is coupled through i-f transformer Z203 to the cathode of detector V208.

3-18. DETECTOR V208. The output of i-f amplifier V207 is applied to the cathode of detector V208. Here the i-f signal is rectified and filtered. Voltage divider R237 and R238 in tank circuit Z208 applies a small positive voltage to the cathode of V208 to insure a more linear operation.

3-19. When a signal is fed to the cathode of V208, current only flows during the negative half of the input cycle. The rectified i-f frequency output signal follows the peaks of the i-f frequency. These peaks approximate the bandpass characteristics of the i-f crystal filters.

3-20. The rectified output signal is applied through a voltage divider network to the grid of vertical deflection amplifier V304.

3-21. VERTICAL DEFLECTION AMPLIFIER V304. The rectified signal output of V208 is applied to the grid of V304 for amplification to drive the vertical deflection plates of the cathode ray tube. The input signal of V304 can be filtered (via VIDEO FILTER control S203) by capacitors C219, C220, or C221, which act as a lowpass filter to reduce noise and beat interference.

3-22. The output of detector V208 applies a negative video pulse to the grid of V304A. Bias voltage is also applied to the grid of V304B, through a voltage divider network. Vertical position control R235 acts as a vertical positioning control by adjusting the bias voltage to V304B. This change of voltage on the grid of V304B changes the output potential with a resultant change of vertical position on the cathode ray tube. The vertical video signal is made available at J201 for application to external equipments, such as an oscilloscope or recorder.

3-23. LOCAL OSCILLATOR AND REACTANCE TUBE V106. Tube V106 serves as the local oscillator, in that it produces a signal nominally centered at 600 kc to heterodyne with the incoming signal (500 kc). Dual triode V106 functions as a Miller Reactance tube V106A varies the oscillator frequency nominally about 600 kc. This tube is essentially an electronically varying capacitor across tank circuit Z103 with the frequency variation being controlled by the sweep (sawtooth). Tube V106B maintains its oscillations through tank circuit Z103.

3-24. The output from local oscillator V106B is applied to the second mixer V103. A portion of this output is applied to frequency discriminator V104 and V105 to stabilize the output of the local oscillator to 600 kc $\pm$1 kc (except for the fixed 10 kc and variable 0 to 100 kc sweep widths).

3-25. SAWTOOTH GENERATOR V301. The sawtooth generator produces a ramp voltage (sawtooth) for the local oscillator V106 and for the horizontal deflection amplifier V303. The sawtooth period is determined by R331, C301, and C303 in the 1 and 10 second positions of S301. With C301 in the VAR. position, the period is determined by the VAR. RATE control R339, R337, and C301. The ramp voltage appearing across C301 or C303 is coupled through cathode follower V302B and SWEEP STABILIZER control R345 to the grid of the thyrotron V301. When the ramp voltage exceeds the ionization potential of V301, the capacitor C301 will be discharged and the cycle will be repeated. The position of R345 will determine the discharge level of V301 and, therefore, will determine the amplitude and period of the sawtooth waveshape.

3-26. CATHODE FOLLOWER V302. The B section of the cathode follower V302 receives the sawtooth from V301 and couples it to the horizontal deflection amplifier V303 and SWEEP WIDTH SELECTOR control S302. D.C. balance control R318 adjusts

the sweep sawtooth potential with respect to chassis ground. SWEEP WIDTH SELECTOR S302 is a six position switch for selecting the desired sweep width of operation. The sawtooth sweep signal is coupled through this switch to cathode follower V302A, to isolate this stage from the following stage. The sawtooth is then coupled through the frequency discriminator where it is superimposed upon the AFC bias to reactance tube V106A.

3-27. FREQUENCY DISCRIMINATOR V104 AND V105. A portion of the local oscillator signal (600 kc) is applied to this circuit for stabilizing the frequency of the local oscillator under conditions of narrow sweep widths. This circuit is not operative in the 10 KC and 0 to 100 KC positions of the SWEEP WIDTH SELECTOR control.

3-28. The sampled 600 kc is applied to the grid of V104 for amplification and limiting. The amplified signal is coupled through a 600 kc transformer, Z104. The transformer is tuned to 600 kc. The output of this transformer is rectified by tube V105. When the signal is at the resonant frequency of the secondary of Z104, the r-f voltage across the secondaryis in phase with that across the primary. Since each diode (tube V105) is connected across one-half of the secondary, the resultant r-f voltages applied to each are equal, and the voltage outputs of tube V105 are equal. Hence, the net voltage is zero. If, however, the signal varies from the resonant frequency, the phase relationship no longer exists between primary and secondary. The resultant voltages applied to diode V105 are no longer equal, and a d-c voltage proportional to the difference between the r-f voltages is produced at the output of V105. This d-c voltage is coupled to reactance tube V106A to return the local oscillator frequency to 600 kc (nominal).

3-29. HORIZONTAL DEFLECTION AMPLIFIER V303. Tube V303 is a twin-triode amplifier functioning as a cathode-coupled, push-pull, balanced amplifier. The use of a balanced amplifier insures proper linearity and minimum distortion of the horizontal sweep voltage.

3-30. The sawtooth is fed from a voltage divider in the cathode circuit of change in magnitude of the sawtooth to the grid of V303B. Tube V303B acts as an amplifier, while tube V303A acts as an inverter and amplifier to produce a signal of the same amplitude, but of opposite polarity at the output of tube V303B. The sawtooth output of V303B and V303A is applied to the horizontal deflection plates of the cathode ray tube.

3-31. Horizontal positioning of the trace is controlled by means of potentiometer R357 and line size control R367. The signal at the cathodes of V303 is made available at the horizontal output jack J301 through resistor R371. The sawtooth output from V302B is also made available at the sync jack J301.

3-32. MARKER OSCILLATOR V108. Tube V108 is used to generate a 500 kc marker for calibrating the Spectrum Analyzer. The marker oscillator is a Pierce oscillator utilizing a 500 kc crystal, Y101. The crystal-controlled marker signal from the grid of V108 is coupled through an isolation filter to the MARKER LEVEL control. The marker signal is applied to the second mixer V103 when the MARKER LEVEL control is rotated clockwise.

3-33. An external audio signal may be applied, via Ext. Mod. jack J107, located on the front panel, and J105 in the rear of the instrument. The external audio signal amplitude modulates the 500 kc signal through diode CR101, and produces frequency markers with known separation.

3-34. CATHODE RAY TUBE V401. Tube V401 is a long-persistence cathode ray tube used with an amber filter, which produces a bright yellow trace without any notable halo. The cathode ray tube operates with approximately 2,500 volts of accelerating potential. A negative 800 volts is applied to the cathode through INTENSITY control R409. A negative voltage is also applied to the first anode through voltage divider R407, R408, and focus control R405.

3-35. In order to insure proper focus on the face of the cathode ray tube, the second anode is kept at the same potential as the horizontal and vertical deflection plates. This is accomplished by dividing a portion of the B+ supply through the ASTIGMATISM control R401 to the second anode.

3-36. POWER SUPPLIES. The B+ supply is an electronically regulated type to supply a positive 270 volts dc to the equipment. The B- supply is derived from diodes CR519 through CR521 and regulating gas tube V506.

3-37. The high voltage for the crt is obtained from a pair of high voltage diodes, CR515 and CR517. The filament supply for most tubes in the analyzer is regulated by transistor Q501 and zener diode CR505. This regulating circuit eliminates the need for an external line voltage regulator to stabilize the filament voltage due to line variations.

SECTION IV

MAINTENANCE

4-1. GENERAL.

4-2. This section contains procedures to be followed for maintaining the equipment in operating condition. Included are: Test equipment, minimum performance standards, circuit trouble shooting procedures, system trouble shooting procedures, tube replacement touch-up procedure, adjustment and alignment instructions, removal and replacement instructions, schematic, and voltage and resistance charts. It is extremely important that this section of the manual be read thoroughly before performing maintenance procedures.

4-3. TEST EQUIPMENT

4-4. Table 4-1 lists the test equipment required to check-out the operation of the Model MD500E and to determine the defective circuit or component if the equipment becomes inoperative. Test equipment of equivalent characteristics can be substituted for the suggested test equipment listed in table 4-1. In any event, all test equipment used must be in good operating condition and properly terminated when required.

4-5. MINIMUM PERFORMANCE STANDARDS

4-6. Table 4-2 details the minimum performance standards for the Model MD500E. The minimum performance standards determine if the equipment is operating satisfactorily upon receipt, repair, or long periods of storage.

Test Equipment	Manufacturer & Type	Application
Audio Oscillator 5 to 500,000 cps	Hewlett-Packard 200 CD	Modulation & sweep width calibration
Signal Generator 80 kc to 30 mc	Measurements Inc. 65 B	Gain calibration & L.O. mixed signals
Vacuum Tube Voltmeter, 11 meg ohm input impedance	RCA Voltohmyst WV-77	Trouble shooting
Oscilloscope 10 meg pf input	Tektronix Type 543	Display of waveforms

Table 4-1. Test Equipment Required.

Step	Purpose	Procedure	Normal Indication	Probable Cause if Indication Abnormal
4	Determine whether crt idsplay is operating. (Cont.)	Set ATTENUATOR switch to 20 D.B. Adjust MARKER LEVEL control for full scale marker pip. Set SCALE switch to DB.	Marker is at 20 DB graduation marking.	Refer to table 4-3, step 11.
		Set ATTENUATOR switch to OUT.	Marker pip is at 0 DB graduation marking.	
5		Set SCALE switch to RMS. Adjust MARKER LEVEL control for full scale marker pip. Rotate RESOLUTION control. Reset RESOLUTION control full clockwise. Turn MARKER LEVEL control to OFF.	Marker pip widens or becomes narrower depending on rotation.	Refer to table 4-3, step 10.
6		Set GAIN control fully clockwise. Apply a 20 microvolt, 500 kc signal to the equipment.	A full scale or greater signal pattern is displayed directly over center graticule	Refer to table 4-3, step 9.

Table 4-2. Minimum Performance Standards (Sheet 2 of 2)

(23)

Step	Purpose	Procedure	Normal Indication	Probable Cause if Indication Abnormal
1	Determine if power is being applied and cathode ray tube edge lighting variation.	Apply a nominal 115 v ac, single phase, 60 cps, power source to the equipment. Turn EDGE LIGHTING control clockwise.	Note crt edge lighting with rotation of EDGE LIGHTING control. Within a short time a dot will appear and begin moving across the screen.	Refer to table 4-3, steps 1 and 2.
2	Determine whether crt display is operating.	Set front panel controls to: SWEEP WIDTH SEL.-0-100 kc SWEEP WIDTH- 100 kc RESOLUTION -Fully clockwise RATE - VAR. VAR RATE - 30 ATTENUATOR - OUT SCALE - RMS VIDEO FILTER -OUT Adjust INTENSITY and FOCUS controls for proper brillance and sharpness of trace.	A sharp, brilliant, uniform trace, positioned properly on screen.	Refer to table 4-3, steps 1 and 3.
3		Turn MARKER LEVEL control clockwise until a full scale marker pip is displayed on crt screen. (Refer to paragraph 2-9, steps 6 thru 11, for adjustment of marker signal.)	A full scale marker pip is displayed directly over center graticule.	Refer to table 4-3, step 4.

Table 4-2. Minimum Performance Standards (Sheet 1 of 2)

WARNING

HIGH VOLTAGES DANGEROUS TO HUMAN LIFE ARE PRESENT IN THE EQUIPMENT. PERSONNEL MUST OBSERVE SAFETY REGULATIONS AT ALL TIMES.

4-7. CIRCUIT TROUBLE SHOOTING PROCEDURES

4-8. The circuit trouble shooting procedures are listed in table 4-3. This procedure follows the procedure given in table 4-2. The probable causes for the symptoms listed in table 4-3 are given in the order of their probable occurance. The defective component or circuit is located in table 4-3 together with the remedy for correcting the malfunction. Table 4-4 is included to isolate a defective component within the i-f circuit. Reference is also made to the system trouble shooting procedures, when required.

4-9. If a tube was replaced, refer to table 4-5 for any touch-up or alignment procedure required. Always check performance of the particular stage to determine if a touch-up or alignment is required.

4-10. When trouble shooting a particular tube circuit, always first ascertain that the proper voltages are being supplied to all tube elements. Many questions concerning the condition of a tube in a given circuit can best be answered by substituting a tube known to be free from defects in place of the questionable tube and comparing the performance of the equipment.

Step	Trouble	Probable Cause	Remedy
1	No power being applied to equipment when EDGE LIGHTING control is rotated clockwise.	No ac power input	1. Check power cord. 2. Check power connection to equipment.
		Fuses defective.	Check fuses. Replace if defective. Never replace a fuse with one of higher current rating. If a fuse burns out immediately after replacement, do not replace it a second time until the cause has been determined and trouble has been corrected.
		EDGE LIGHTING control S501 defective.	Check continuity of switch S501, replace if defective.
		Power supply component defective.	Refer to paragraph 4-11, step 1.
2	Screen illumination (edge lighting) is off or does not vary with rotation of EDGE LIGHTING control.	Defective control R509 or edge lighting circuit.	Check continuity of R509, transformer T505, and/or lamps DS501 thru DS505. Replace defective component.
3	Low intensity of spectrum, erratic or no trace.	Power supply component defective	Refer to paragraph 4-11, step 1.
		Horizontal deflection circuit defective.	Replace tube V303 and/or associated defective component.
		Vertical deflection circuit defective	Replace tube V304 and/or associated defective component.
		Sweep circuit defective.	Refer to paragraph 4-11, step 2.

Table 4-3. Circuit Trouble Shooting Table (Sheet 1 of 2)

Step	Trouble	Probable Cause	Remedy
3	Low intensity or spectrum, erratic or no trace.(Cont.)	I-f Circuit.	Refer to table 4-4.
		Defective cathode ray tube.	Replace tube V401 and/or associated defective component.
4	No 500 kc marker pip on screen.(Input test signals correct)	Marker oscillator circuit.	Replace tube V108 and/or crystal Y101 and/or associated defective component.
5	Applied r-f test signals not displayed on screen. (Marker pip correct)	First mixer circuit	Replace tube V101 and/or associated defective component.
		R-f amplifier circuit	Replace tube V102 and/or associated defective component.
6	No variation of signal pip with rotation of RESOLUTION control.	RESOLUTION control defective	Recouple gear train or replace.
7	Input signals do not appear at correct freqc graduations.	Local Oscillator circuit.	Replace tube V106 and/or associated defective component. Realign, refer to para. 4-26.
		Discriminator circuit	Replace tube V104 or V105 and/or associated defective component. Realign. Refer par 4-27.
8	Instability or drift of input signal pips.	Discriminator circuit	Replace tube V104 or V105 and/or associated defective component.
9	Loss in sensitivity	I-f circuit.	Refer to table 4-4.
		Local oscillator circuit.	Replace tube V106 and/or associated defective component.
		R-f input circuit.	Replace tube V101,V102 or V103 and/or associated defective component.
10	Selectivity (res.) erratic or improper.	Crystal filters V201, V203, or V204 or crystals Y201,Y202,or Y203	Replace defective tube or crystals. Realign per par. 4-24.
11	Log. display not correct (lin. display correct.	SCALE switch S202 and/or log shaping circuit. Tube V207.	Replace defective component. Realign per Par. 4-20.

Table 4-3. Circuit Trouble Shooting Table (Sheet 2 of 2)

Step	Trouble	Procedure	Normal Indication	Probable Cause if Indication Abnormal
1	I-F Circuit	Set front panel controls to: SWEEP WIDTH SEL.-0-100kc SWEEP WIDTH - 100kc RESOLUTION - Fully Clockwise RATE - Var VAR RATE - 30 cps ATTENUATOR - OUT SCALE -RMS VIDEO FILTER - OUT EDGE LIGHTING - clockwise Apply a 100 kc, 10 volts signal to pin 7 of tube V208.	A baseline deflection to the top of the graticule.	If indication is normal, proceed to step 2. If indication is abnormal, replace tube V208 and/or associated defective circuitry.
2		Apply a 100 kc, 100 mv signal to pin 1 of tube V207.	A baseline deflection to the top of the graticule.	If indication is normal, proceed to step 3. If indication is abnormal, replace tube V207 and/or associated defective circuitry.
3		Apply a 100 kc, 3 mv signal to pin 1 of tube V206.	A baseline deflection to the top of the graticule.	If indication is normal, proceed to step 4. If indication is abnormal, replace

Table 4-4. I-F Circuit Trouble Shooting Table (Sheet 1 of 3)

Step	Trouble	Procedure	Normal Indication	Probable Cause if Indication Abnormal
3 (Cont.)				tube V206 and/ or associated defective circuitry.
4		Apply a 100 kc, 2.5 mv signal to pin 1 of tube V205.	A baseline deflection to the top of the graticule.	If indication is normal, proceed to step 5. If indication is abnormal, replace tube V205 and/or associated defective circuitry.
5		Apply a 100 kc, 4.5 mv signal to pin 6 of tube V204. Adjust frequency of applied signal for max. vertical rise of baseline.	A baseline deflection to the top of graticule.	If indication is normal, proceed to step 6. If indication is abnormal, replace tube V204 and/or associated defective circuitry.
6		Apply a 100 kc, 30 mv signal to pin 6 of tube V203. Adjust freq. of applied signal for max. vertical rise of baseline.	A baseline deflection to the top of graticule.	If indication is n normal, proceed to step 7. If indication is abnormal, replace tube V203, and/or associated defective circuitry.
7		Apply a 100 kc, 300 uv signal to pin 1 of tube V202.	A baseline deflection to the top of graticule.	If indication rormal proceed to step 8. If abnormal, replace tube V202 and/or associated defective circuitry.

Table 4-4. I-F Circuit Trouble Shooting Table (Sheet 2 of 3)

Step	Purpose	Procedure	Normal Indication	Probable Cause if Indication Abnormal
8		Apply a 100 kc, 900 uv signal to pin 6 of V201. Adjust the freq. of the applied signal for max. vertical rise of base-line.	A baseline deflection to the tope of the graticule.	If indication is abnormal, replace tube V201 and/or associated defec-tive circuitry. If indication is normal, i-f cir-cuit operating properly.

(30)

Table 4-4. I-F Circuit Trouble Shooting Table (Sheet 3 Of 3)

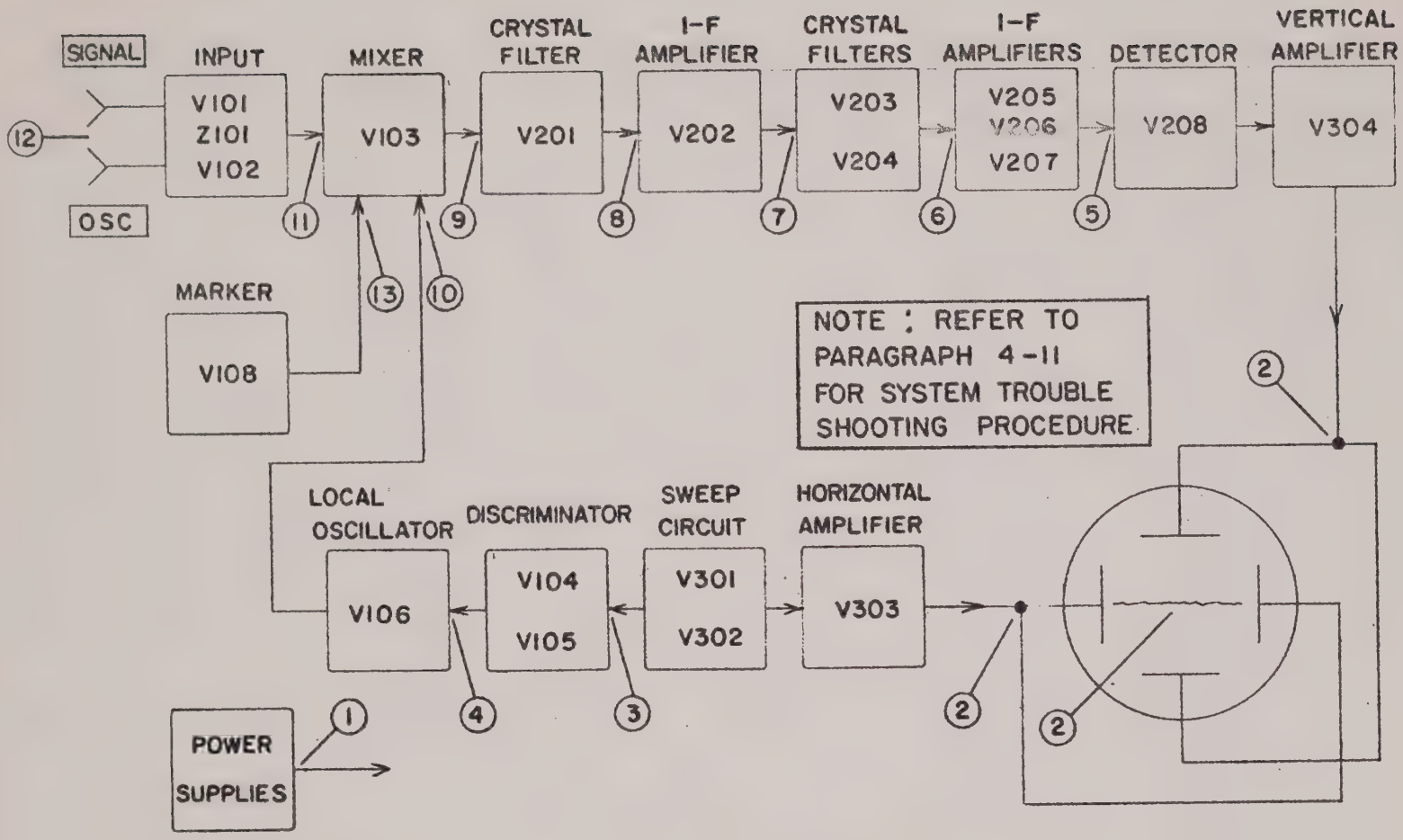


FIGURE 4-1. SYSTEM TROUBLE SHOOTING BLOCK DIAGRAM

4-11. SYSTEM TROUBLE SHOOTING PROCEDURE.

4-12. The following procedure should be used to isolate an equipment malfunction to a particular stage as shown in figure 4-1. This procedure checks out all the icrcuitry of the Model MD500E and is to be followed when an equipment malfunction cannot be located by using the detailed trouble shooting procedures given in tables 4-3 and 4-4.

NOTE

All internal adjustment controls have been factory set for optimum equipment operation. Therefore, in isolating a trouble, adjustment of these controls should not be made.

4-13. Set the front panel controls to:

SWEEP WIDTH SELECTOR	-	0-100 kc
SWEEP WIDTH	-	100 kc
RESOLUTION	-	Fully clockwise
RATE	-	Var
VAR RATE	-	30
ATTENUATOR	-	OUT
SCALE	-	RMS
VIDEO FILTER	-	OUT
MARKER LEVEL	-	OFF
GAIN	-	Fully clockwise

4-14. Turn EDGE LIGHTING control clockwise.

NOTE

The following stesp are numbered in the same relationship as shown in figure 4-1.

(1) Check power supplies as indicated in the table below:

Multimeter Connected Between Ground and	Power Supply Being Checked	Indication (vdc) Min.	Max.	Adjustment
J505	+270 vdc	+270	+270	R539
V506, pin 7	-108 vdc			None
Junction of R515 and R517	+1500 vdc	1350	1650	None
Junction of R513 and C507B	-800 vdc	-720	-880	None
J503	-12 vdc	-12	-12	R503

If any of the above power supply voltages cannot be obtained (even after adjustment), trouble shoot the associated circuit of the defective power supply for defective tube(s) and/or component(s). If all indications are normal, proceed to step (2).

(2) Check the sweep circuit by observing if a trace is visible on the crt screen. If the trace is not visible, follow the procedure given below. If the trace is observed, proceed to step (3).

a. With a multimeter, record the voltage between pin 1 of V304 and ground; and between pin 6 of V304 and ground. The two voltages should be within 10% of each other. If improper, replace tube V304 and/or defective associated circuitry.

b. With the multimeter, record the voltage between pin 1 of tube V303 and ground; and between pin 6 of V303 and ground. The two voltages should be within 10% of each other. If improper, replace tube V303 and/or defective associated circuitry.

c. Check cathode ray tube and associated circuitry for defective component(s).

(3) Connect an oscilloscope to pin 3 of tube V302. Note the sawtooth waveshape displayed on the oscilloscope has an amplitude of approximately 15 volts and a Rep. Rate of 30 cps. Set the RATE control to 1 sec. Note the duration of the sawtooth is 1.0 second. Set the RATE control to 10 sec. Note the duration of the sawtooth is 10 seconds. Reset the RATE control to VAR. Set the SWEEP WIDTH control to 2 KC. Set the SWEEP WIDTH SELECTOR control as indicated in the following table, and note the amplitude of the sawtooth displayed on the oscilloscope.

SWEEP WIDTH SELECTOR control setting	Sawtooth Amplitude
0 - 2 kc	15 volts plus R.F. envelope
150 cps	1 volt plus R.F. envelope
500 cps	4 volts plus R.F. envelope
2 kc	15 volts plus R.F. envelope
10 kc	1.5 volts, little of no R.F. envelope

If above measurements are improper, replace tube V301 or V302 and/or defective associated circuitry. Refer to paragraph 4-25 for adjustment.

(4) Set the SWEEP WIDTH SELECTRO control to 2 kc. Connect the oscilloscope to pin 5 of tube V104. A 150 volts p-p, sweeping sine wave signal (between 599 and 601 kc) should be observed. If improper, replace tube V104 and/or associated defective circuitry. Connect the oscilloscope to pin 1 or 5 of tube V105. A sawtooth waveshape with a small positive (approx. 1 volt) dc level should be observed. If improper, replace tube V105 and/or associated defective circuitry. (Refer to paragraph 4-27 for alignment procedure if a component was replaced.) Disconnect oscilloscope.

(5) Apply a 100 kc, 10 volt signal to pin 7 of V208. A horizontal base line rise of 10 boxes should be observed on the crt screen. If improper, replace tube V208 and/or defective associated circuitry. If proper, proceed to step (6).

(6) Apply a 100 kc, 2.5 millivolt signal to pin 1 of tube V205. A full-scale base line deflection should be observed on the crt screen. If improper, replace tube V205, V206, or V207 and/or defective associated circuitry. If proper, proceed to step (7). (Refer to table 4-4 for more detailed trouble shooting procedures of the i-f circuit.)

(7) Apply a 100 kc, 30 millivolt signal to pin 6 of tube V203. Adjust the frequency of the applied signal for maximum base line rise on the crt screen. A full-scale base line deflection should be observed. If improper, replace tube V203 or V204 and/or defective associated circuitry. (Refer to paragraph 4-24 for alignment of the crystal filters if crystal Y202 or Y203, or an associated component was replaced.) If proper, proceed to step (8).

(8) Apply a 100 kc, 300 uv signal to pin 1 of V202. Adjust the frequency of the applied signal for maximum base line rise of the crt screen. A full-scale base line deflection shojld be observed on the crt screen. If improper, replace tube V202 and/or defective associated circuitry. If proper, proceed to step (9).

(9) Apply a 100 kc, 900 uv signal to pin 6 of tube V201. Adjust the frequency of the applied signal for maximum base line rise on the crt screen. A full-scale base line deflection should be observed on the crt screen. If improper, replace tube V201 and/or defective associated circuitry. (Refer to paragraph 4-27 for alignment of the crystal filters if crystal Y201, or an associated component was replaced.) If proper, proceed to step (10).

(10) Connect the oscilloscope to pin 6 of tube V106. A sweeping sine wave signal (between 599 and 601 kc) of approximately 50 volts p-p, should be observed. If improper, replace tube V106 and.or associated defective circuitry. (Refer to paragraph 4-26 for alignment of the local oscillator if a component was replaced.) If proper, proceed to step (11).

(11) Apply a 500 kc, 6.5 millivolt signal to pin 2 of V103. A full-scale pip deflection should be observed on the crt screen. If improper, replace tube V103 and/or defective associated circuitry. If proper, proceed to step (12).

(12) Apply a 200 uv, 1,000 kc signal to the SIGNAL connector. Apply a 1.5 volt, 1,500 kc signal to the OSC. connector. Set the GAIN control fully clockwise. A full-scale or greater pip deflection should be observed on the crt screen. If improper, replace tube V101 and/or defective associated circuitry. Disconnect test signals.

(13) Turn the MARKER LEVEL control clockwise. Note a marker pip displayed at the center of the crt screen. If improper, replace tube V108 or crystal Y101 and/or associated defective circuitry.

Reference Symbol	Tube Type	Adjustment to be made
V101, V102	12AT7	None
V103	12AT7	None (In some cases, a light peaking of Z102 may be required).
V108	6AB4	None
V104	6BH6	AFC Balance control 149, refer to paragraph 4-27. Transformer Z104, refer to paragraph 4-27.
V105	6AL5	None
V106	12AT7	Local Oscillator alignment, refer to paragraph 4-26.
V201,V203,V204	6AB4	None (In some cases, a slight adjustment of the crystal filters may be required.
V202,V205,V206 V207	12AU6	None (In some cases, a slight peaking of the associated i-f transformer coil may be required.)
V208	6C4	DB Shape and Range controls, refer to paragraph 4-20.
V301	5696	Sweep Stabilizer and D.C. Balance controls, refer to paragraph 4-25.
V302	12AT7	None
V303,V304	12AX7	Presentation controls, refer to paragraph 2-10.
V401	5ADP7	Presentation controls, refer to paragraph 2-10.
V503,V504,V505	6AS7,12AU6, 5651	B+ Adjust control, refer to paragraph 4-19.
V506	0B2	None
Q501	2N277	Fil. Adjust R503, refer to paragraph 4-18.

Table 4-5. Tube Replacement Adjustment Procedure.

4-15. ADJUSTMENT AND ALIGNMENT INSTRUCTIONS

4-16. The following paragraphs detail the procedure for adjusting various internal controls which may be required due to the replacement of components or aging of tubes. Instructions are also provided for alignment of the i-f circuit, sweep circuit, crystal filters, local oscillator, and discriminator circuits. Refer to tables 4-2 through 4-5 to determine the applicable adjustment or alignment procedure required to bring the Model MD500E to satisfacotry operating condition. Allow at least 30 minutes of warm up time for the equipment to stabilize before performing an adjustment or alignment procedure.

4-17. ADJUSTMENTS

4-18. FILAMENT ADJUST. Connect a multimeter between J503 and ground. Adjust Fil. Adjust control R503 until multimeter indicates exactly 12 volts dc.

4-19. B+ ADJUST. Connect a multimeter between J505 and ground. Adjust B+ Adjust control R539 until multimeter indicates exactly 270 volts dc.

4-20. DB SHAPE CONTROL R263 and DB RANGE CONTROL 269. These controls are used to set the log shaping circuit for proper logarithmic display on the crt. Follow the procedure below to perform this adjustment.

(1) Perform the preliminaay operating procedure, paragraph 2-9, steps 1 through 12, only.

(2) Adjust MARKER LEVEL control for full scale marker pip.

(3) Set SCALE switch to DB.

(4) If the marker pip is not directly at the 20 DB screen indication, adjust DB shape control R263 until marker pip is directly at 20 DB screen indication.

(5) Set ATTENUATOR switch to OUT.

(6) Adjust DB Range control R263 until the marker pip is at the 0 DB screen indication.

(7) DB Range control R269 and Shape Control R263 may require several back-and-forth adjustments before the marker pip accurately follows the scale calibrations.

4-21. GAIN CALIBRATE CONTROL R241. This control is used to calibrate the crt screen for voltage measurements. To adjust this control proceed as follows:

(1) Perform the preliminary operating procedure, refer to para-

graph 2-9.

(2) Apply a 500 kc, 10 u volt signal to the equipment.

(3) Adjust control 241 to give a full scale signal deflection on the crt screen.

4-22. ALIGNMENT PROCEDURES

4-23. I-F CIRCUIT. The following procedure is given for aligning the i-f circuit.

(1) Set the fron panel controls to:

SWEEP WIDTH SELECTOR	-	0-100 kc
SWEEP WIDTH	-	100 kc
RESOLUTION	-	Fully clockwise
RATE	-	VAR
VAR RATE	-	30
ATTENUATOR	-	OUT
SCALE	-	RMS
VIDEO FILTER	-	OUT
GAIN	-	Fully clockwise

(2) Remove the unit from the cabinet. Remove the bottom plate and i-f bottom plate.

(3) Set the Gain Calibrate control R241 to its mid-range.

(4) Turn the EDGE LIGHTING control clockwise and allow 30 minutes for the equipment to warm up.

(5) Apply a 100-kc signal through a 0.01 capacitor to pin 1 of tube V207. Adjust the 100 kc signal level until the baseline on the crt screen is about halfway up on the screen.

NOTE

Use the 0.01 capacitor in all remaining steps.

(6) Adjust i-f transformer coil Z203 for maximum vertical deflection of the baseline. The level of the applied 100 kc signal should be approximately 100 millivolts. Remove the signal.

(7) Apply the 100 kc signal to pin 1 of tube V206. Adjust i-f transformer Z202 for maximum vertical deflection of the baseline. The level of the applied 100 kc signal should be approximately 3 millivolts. Remove the signal.

(8) Apply the 100 kc signal to pin 1 of tube V205. Adjust the i-f transformer Z201 for maximum vertical deflection of the baseline. The level of the applied 100 kc signal should be approx-

imately 2.5 millivolts. Remove the signal.

(9) Apply the 100 kc signal to pin 6 of tube V204. Slightly adjust the frequency of the 100 kc signal for maximum vertical deflection of the baseline. The level of this signal should be approximately 4.5 millivolts. Remove the signal.

(10)Apply the 100 kc signal to pin 6 of tube V203. Slightly adjust the frequency of the 100 kc signal for maximum vertical rise of the baseline. Adjust the level of thel00 kc signal for maximum vertical deflection of the baseline. The level of this signal should be approximately 30 millivolts. Remove the signal.

(11)Apply the 100 kc signal to pin 1 of tube V202. The level of the applied 100 kc signal should be approximately 300 u volts. Remove the signal.

(12)Apply the 100 kc signal to pin 6 of tube V201. Slightly adjust the frequency of the 100 kc signal for maximum vertical rise of the baseline. Adjust the level of the 100 kc signal for maximum vertical deflection of the baseline. The level of the applied 100 kc signal should be approximately 900 u volts. Repeak transformers Z201, Z202, and Z203 for maximum vertical deflection of the baseline. Remove the signal.

(13)Apply a 500 kc signal to pin 2 of tube V103. Adjust transformer Z102 for full-scale signal pip. The level of the applied 500 kc signal should be approximately 6.5 millivolts. Remove the signal.

(14)Connect an oscilloscope to pin 7 of tube V103. Note that the frequency displayed is sweeping around 600 kc at an amplitude of 6 volts. Disconnect the oscilloscope.

(15)Apply a 500 kc, 100 u volt signal to pin 7 of tube V102. Note a full-scale signal pip is directly at the center of the screen.

(16)Apply a 500 kc, 10 u volt signal to the front panel SIGNAL receptacle. Note a full-scale signal pip is directly at the center of the screen. If required, adjust Gain Calibrate control R241 for full-scale signal pip.

4-24. CRYSTAL FILTER V201, V203, AND V204. Alignment of this circuit should only be perofrmed afte replacement of crystal Y201, Y202, or Y203; and in some cases after tube V201, V202, V203, V204, or V205 was replaced. To align this circuit proceed as follows:

(1) Set front panel controls to:

SWEEP WIDTH SELECTOR	-	0-100 kc
SWEEP WIDTH	-	100 kc
RESOLUTION	-	Fully clockwise

RATE	-	VAR
VAR RATE	-	30
ATTENUATOR	-	OUT
SCALE	-	RMS
VIDEO FILTER	-	OUT
GAIN	-	Fully Clockwise

(2) Remove the unit from the cabinet. Remove the bottom plate and i-f bottom plate. Turn EDGE LIGHTING control clockwise Allow 30 minutes for the equipment to warm up.

(3) Apply a 500 kc signal to the SIGNAL connector. Adjust the level of the 500 kc signal for a full scale signal pip. Adjust the CENTER FREQ. control until the signal pip is directly at the center of the screen. Gradually reduce the sweep width, at the same time continuously readjusting the CENTER FREQ. control to keep the pip on the screen until the base of the pip occupies approximately 25 percent of the deviation scale.

(4) Mark the position of the crystals in their sockets. It is important when replacing the crystals to replace them in their original orientation with respect to their sockets.

(5) Remove crystals Y201 and Y202. Short-out sockets of removed crystals with a clip lead.

(6) Set the RESOLUTION control to the center of its range. At this setting, the signal pip should appear as in Figure 4-2.

(7) Adjust capacitor C223, and note the change in pip shape. The rejection slot should sharpen and disappear on one side of the pip and approach from the other side. Adjust capacitor C223 for maximum suppression of the rejection slot.

(8) Tune coil L213 for minimum height and broadest pip. (Note: As the pip decreases in amplitude it may be necessary to increase the input signal level to maintain a readable deflection on the screen.)

(9) Check for correct adjustment by adjusting sweep width control until pip base occupies about 25-percent of the screen baseline. Adjust the input signal level for full-scale pip deflection. Note the pip should remain approximately symmetrical and no rejection slot should appear. Set the SCALE switch to DB and adjust the input signal level for a full-scale pip deflection. Set the ATTENUATOR switch to 20 D.B. and adjust the input signal level for a full-scale pip deflection. Note in each case that the pip remains approximately symmetrical and no rejection slot appears. Readjust capacitor C223 as required.

(10)Remove crystal Y203. Short-out sockets of removed crystal with a clip lead.

(11)Remove clip lead from crystal socket of Y202. Insert

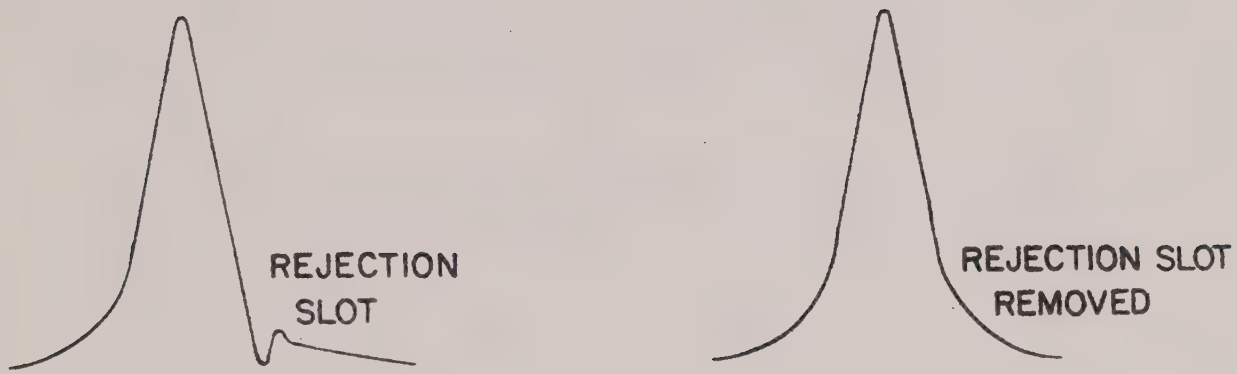


FIGURE 4-2 REJECTION SLOT REMOVAL

crystal Y202 in its socket. Repeat stesp (6) through (9) except adjust capacitor C217 and coil L209 as required.

(12)Remove crystal Y202. Short-out sockets of removed crystal with a clip lead.

(13)Remove clip lead from crystal socket of Y201. Insert crystal Y201 in its socket. Repeat steps (6) through (9) except adjust capacitor C203 and coil L203 as required.

(14)Replace crystals Y202 and Y203. Repeat step (9) above and adjust associated crystal capacitor as required. If there is not change when adjusting one of the capacitors, restore it to its original setting and adjust one of the other capacitors.

(15)Adjust Gain Compensate control R247 for constant amplitude of optimum resolved signal pip as the RESOLUTION control is rotated from maximum to minimum. Adjust VAR RATE and SWEEP WIDTH controls as required.

4-25. SWEEP CIRCUIT. To align the sweep circuit proceed as follows:

(1) Set front panel controls to :

SWEEP WIDTH SELECTOR	-	0 to 100 kc
SWEEP WIDTH	-	100 kc
RESOLUTION	-	Full clockwise
RATE	-	1 Sec. Fixed
ATTENUATOR	-	OUT
SCALE	-	RMS
VIDEO FILTER	-	OUT

(2) Turn EDGE LIGHTING control clockwise.

(3) Adjust Sweep Stabilizer control R345 until the Sweep Rate is exactly 1 second,as determined by use of a watch.

(4) If baseline is not symmetrical on screen, or shifts when Line Size control R320 is varied, adjust D.C. Balance control R349 to position baseline trace. Baseline trace should extend about 1/8 inch past deviation markings on both sides of graticule.

4-26. LOCAL OSCILLATOR V106. To align the local oscillator, proceed as follows:

(1) Set front panel controls to:

SWEEP WIDTH SELECTOR	-	0 to 100 kc
SWEEP WIDTH	-	100 kc
RESOLUTION	-	Fully clockwise
RATE	-	VAR

VAR RATE	-	30
ATTENUATOR	-	OUT
VIDEO FILTER	-	OUT
SCALE	-	RMS
CENTER FREQ.	-	Mid-range

(2) Turn EDGE LIGHTING control clockwise.

(3) Set SWEEP WIDTH MAX. control R325 to mid-range.

(4) Turn MARKER LEVEL control clockwise and adjust for full-scale pip.

(5) Connect an accurate 50 kc signal to External Modulation jack. Adjust the level of the 50 kc signal for useable sidebands.

(6) Adjust the core of Z103 to center the 500 kc marker pip on the screen.

(7) Adjust the SWEEP WIDTH MAX. control R325 to place the 50 kc sideband signals directly over the 100% graduation markings. If necessary, adjust G.M. control R167 and the trimmer capacitor, located in the top of Z103, as required.

(8) If the marker pip shifts slightly from the center of the screen, readjust Z103.

(9) The above procedure may have to be repeated in order to optimize this adjustment.

4-27. DISCRIMINATOR. To align the discriminator proceed as follows:

(1) Set front panel controls as follows:

SWEEP WIDTH SELECTOR	-	10 kc
RESOLUTION	-	Fully clockwise
RATE	-	VAR
VAR RATE	-	30
ATTENUATOR	-	OUT
SCALE	-	RMS
VIDEO FILTER	-	OUT

(2) Before aligning the discriminator, the local oscillator must be adjusted, refer to paragraph 4-26.

(3) Turn EDGE LIGHTING control clockwise.

(4) Turn MARKER LEVEL CONTROL CLOCKWISE, and set for full-scale marker pip.

(5) Center the marker pip by adjusting the CENTER FREQ. control.

(6) Set the SWEEP WIDTH SELECTOR to 500 cps position. The marker pip should appear near the center of the screen. Adjust RESOLUTION and VAR RATE controls as required. Set the SWEEP WIDTH SELECTOR to 150 cps position. If the marker pip is off-screen or cannot be centered, adjust the top core of Z104 to center the marker pip.

(7) Set the RATE control to 1 SEC and 10 SEC; in each setting, adjust the top core of Z104 to center the marker, if required.

(8) Repeat steps 6 and 7 until the pip is centered on all sweep ranges.

(9) Set SWEEP WIDTH SELECTOR to 2 kc. Set RATE control to VAR. Set VAR RATE control approximately to 5 cps.

(10)Apply a 1 kc signal to the External Modulation jack.

(11)Adjust the bottom core of Z104 for maximum separation of 1 kc sideband signals.

(12)Adjust AFC Balance control R149 to position 1 kc sideband signals directly over 100% graduation markings. The top core of Z104 may require a slight adjustment.

(13)If the top core of Z104 was readjusted, steps r through 12 should be repeated to insure optimum adjustment.

4-28. REMOVAL AND REPLACEMENT INSTRUCTIONS

4-29. To remove the main chassis from the cabinet, remove the eight screws from the sides of the front panel and pull the chassis from the cabinet. Side brackets on the main chassis enable the equipment to be placed in any convenient position for ease of maintenance. The right side bracket has two spare fuses and an alignment tool. To obtain access to the i-f circuit remove the two bottom plates.

4-30. CATHODE RAY TUBE. To remove the cathode ray tube, proceed as follows:

(1) Remove the four screws from bezel, screen, and amber filter.

(2) Remove cathode ray tube socket and unscrew neck clamp screw.

(3) Push cathode ray tube as far back into the mu-metal shield as possible.

(4) When the cathode ray tube is clear of the rubber ring, remove the rubber ring and cathode ray tube.

(5) To reinstall a cathode ray tube, proceed as follows.

(6) Insert the cathode ray tube in the shield, pushing as far back as possible.

(7) Be sure anode connection is facing up.

(8) Replace rubber ring, and then dust rubber ring with a fine talc powder to prevent the tube from sticking in the rubber ring.

(9) Push cathode ray tube forward by placing the palm of the hand on socket end of the tube and pushing forward with even pressure.

(10)Replace the tube socket and attach anode connector.

(11)Turn-on the equipment. If the trace does not line up parallel with the horizontal lines on the screen, push the tube back until it clears the rubber ring, and turn the tube until the trace aligns with screen markings.

(12)Push tube back into rubber ring.

(13)Replace screen, filter, and bezel.

4-31. EDGE LIGHTING LAMPS. To remove a defective lamp, proceed as follows:

(1) Remove bezel, filter, and screen.

(2) Four edge lighting lamps are now visible.

(3) Push-in, turn counterclockwise, and remove defective lamp.

(4) Push-in new lamp in place and turn it clockwise until it locks.

(5) Replace screen, filter, and bezel.

4-32. SCHEMATIC.

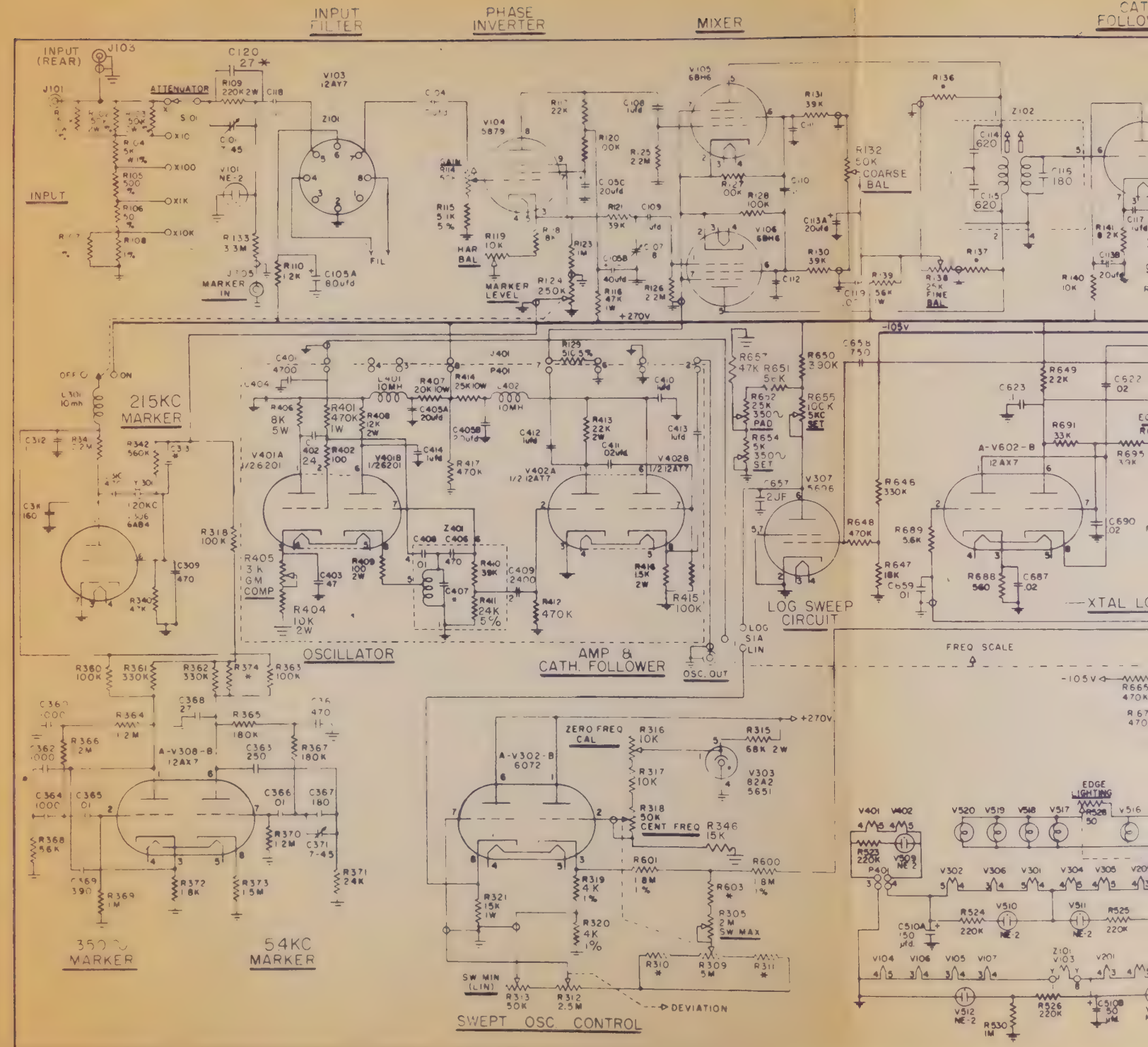
4-33. Figure 4-3 shows the entire circuitry of the Model MD500E Spectrum Analyzer. This diagram should be used in conjunction with Section III to help the operator understand the operation of the equipment. Used in conjunction with this section, it facilitates signal tracing and continuity testing during maintenance.

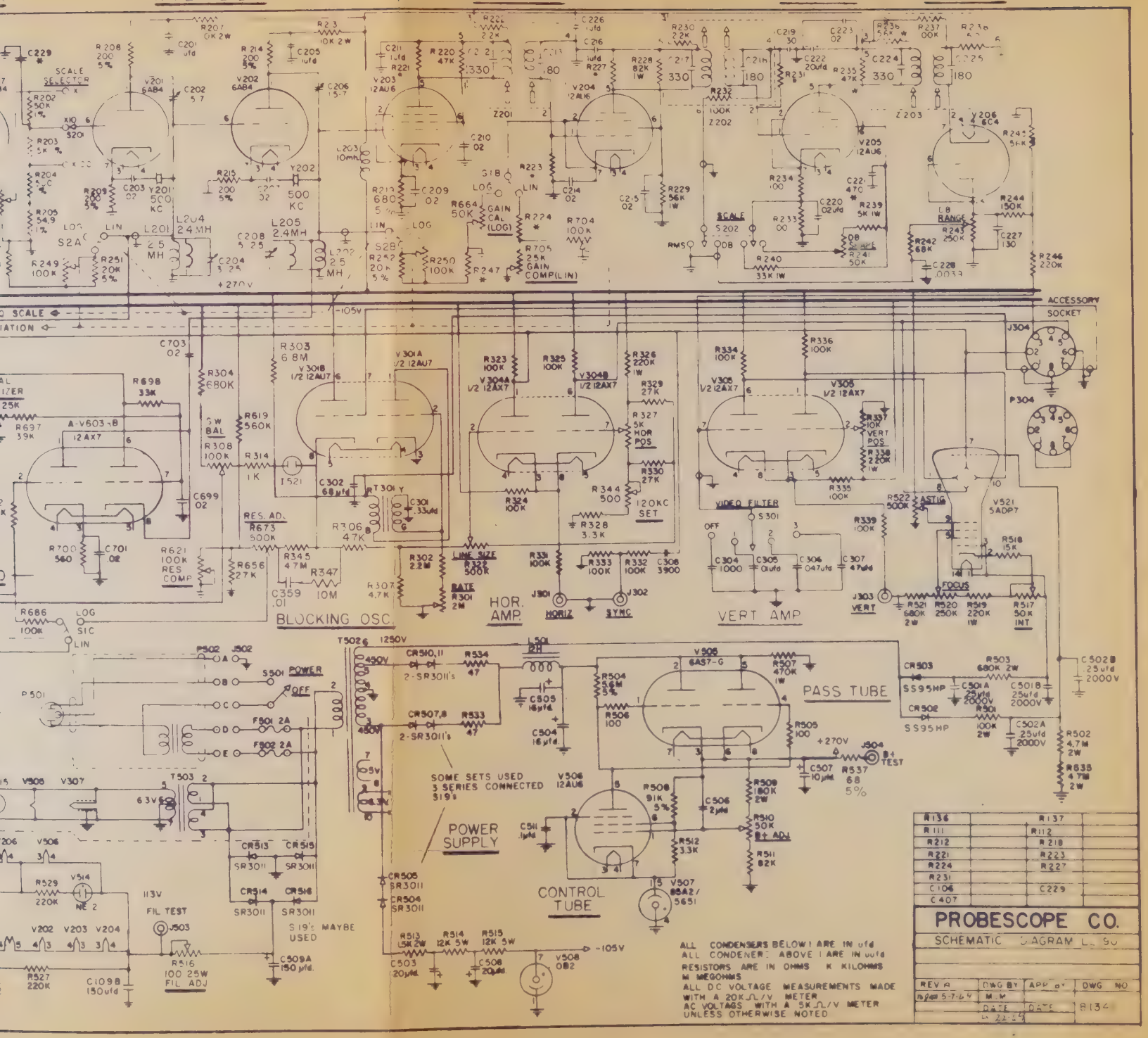
4-34. VOLTAGE AND RESISTANCE CHARTS.

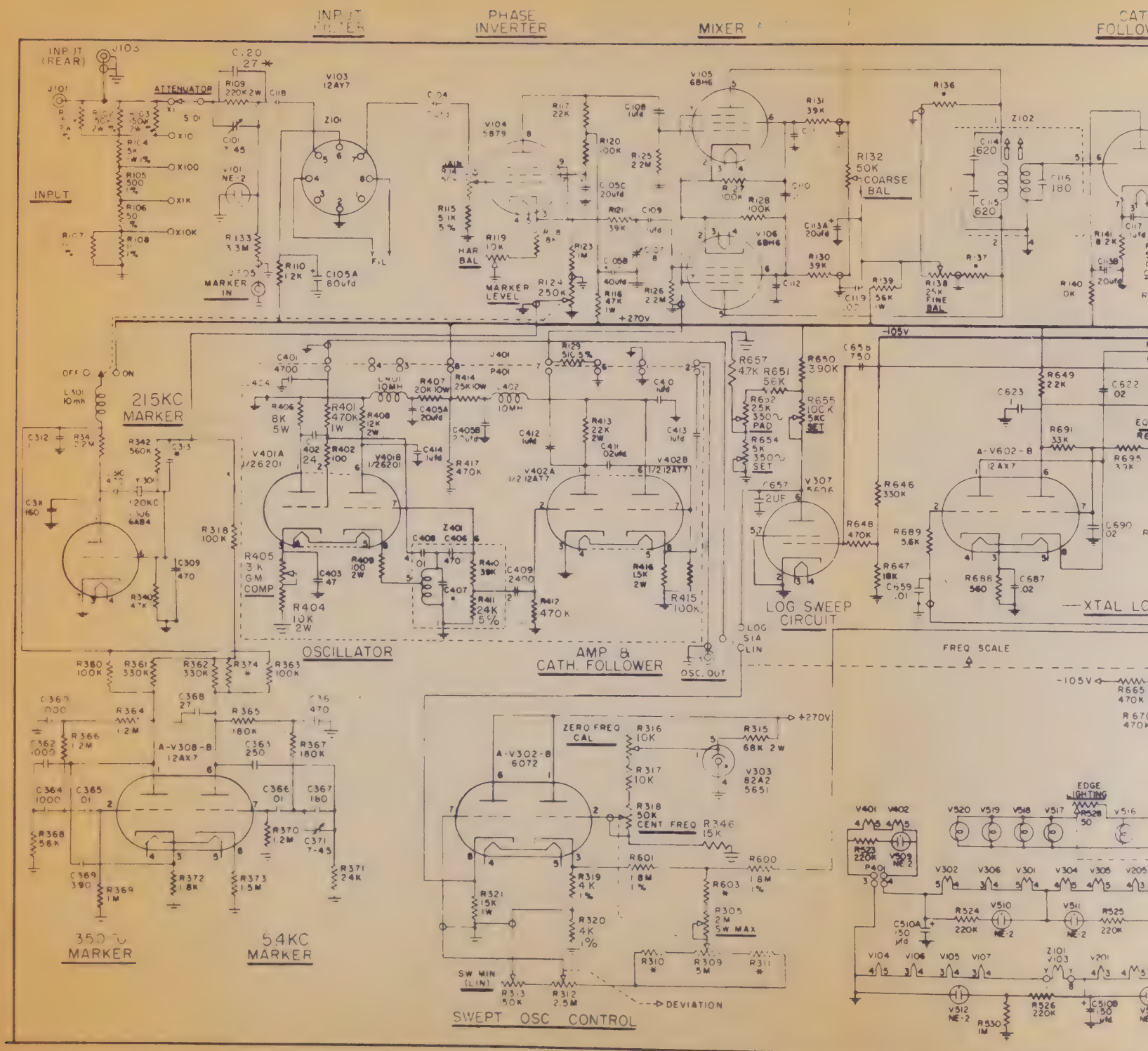
4-35. Voltage and resistance charts, tables 4-6 through 4-8, should be used in conjunction with the trouble shooting procedures to aid in locating defective component(s) in malfunctioning or inoperative circuits.

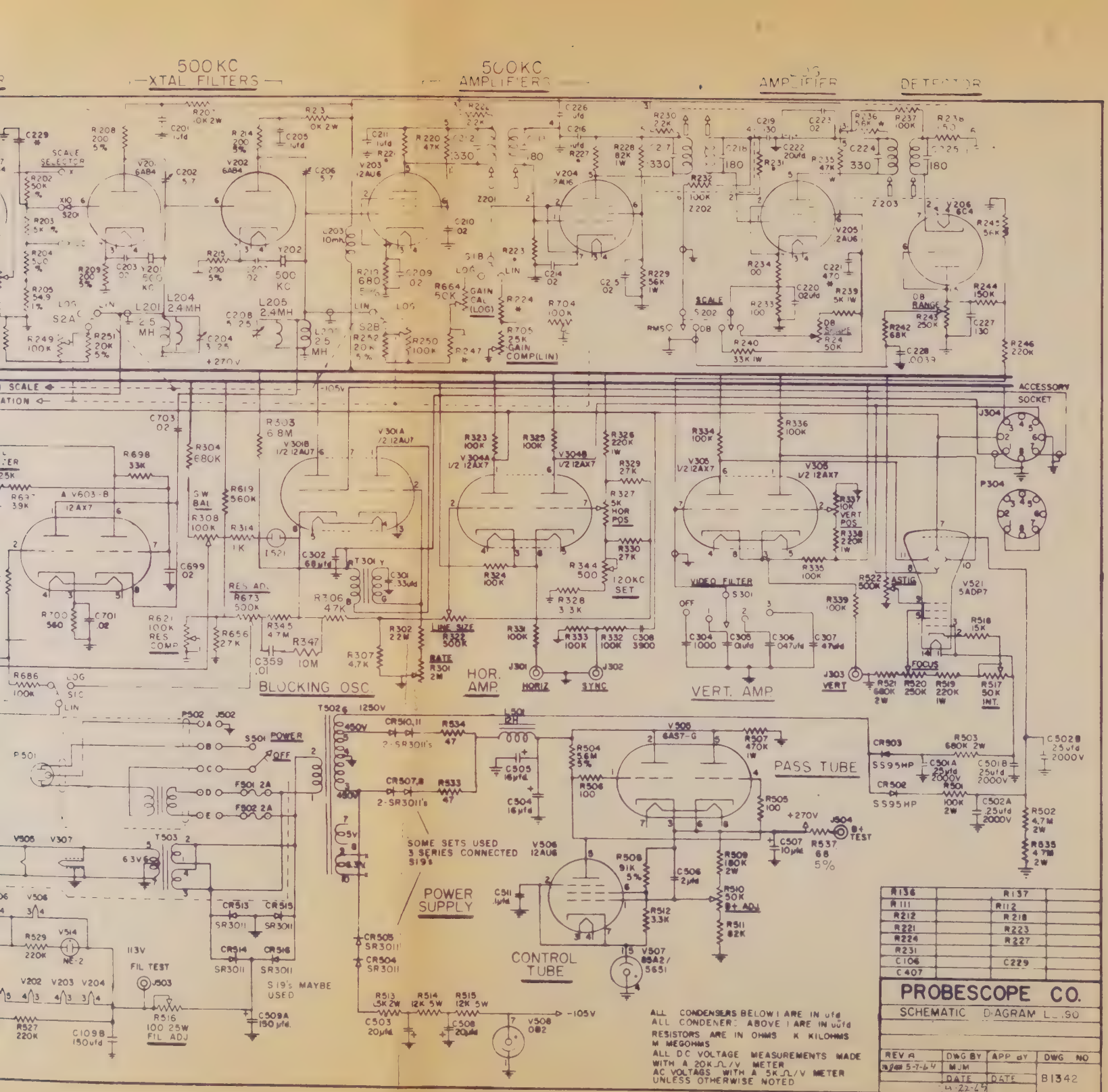
4-36. LUBRICATION.

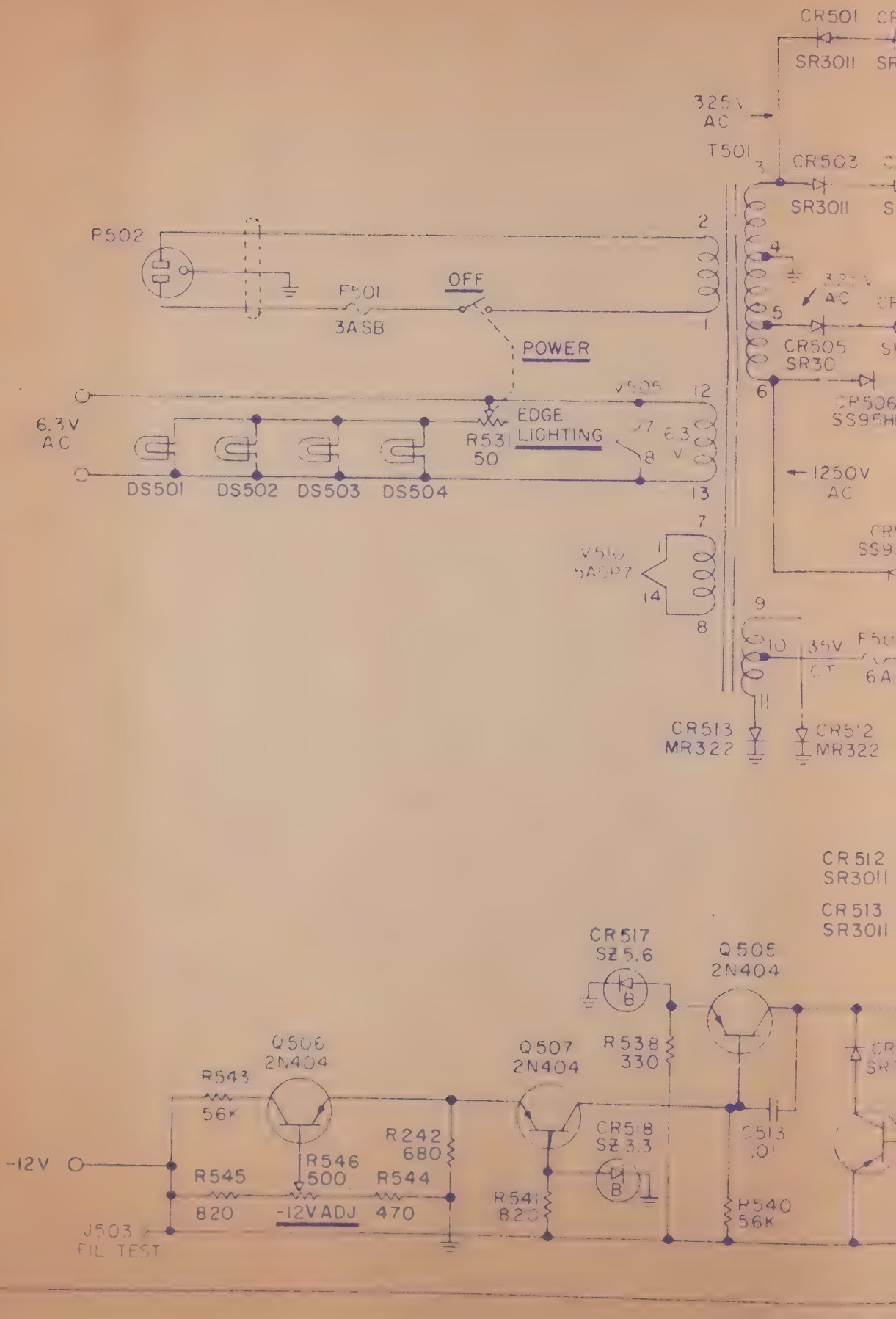
4-37. The Model MD500E requires no lubrication other than that applied at the time of manufacture.

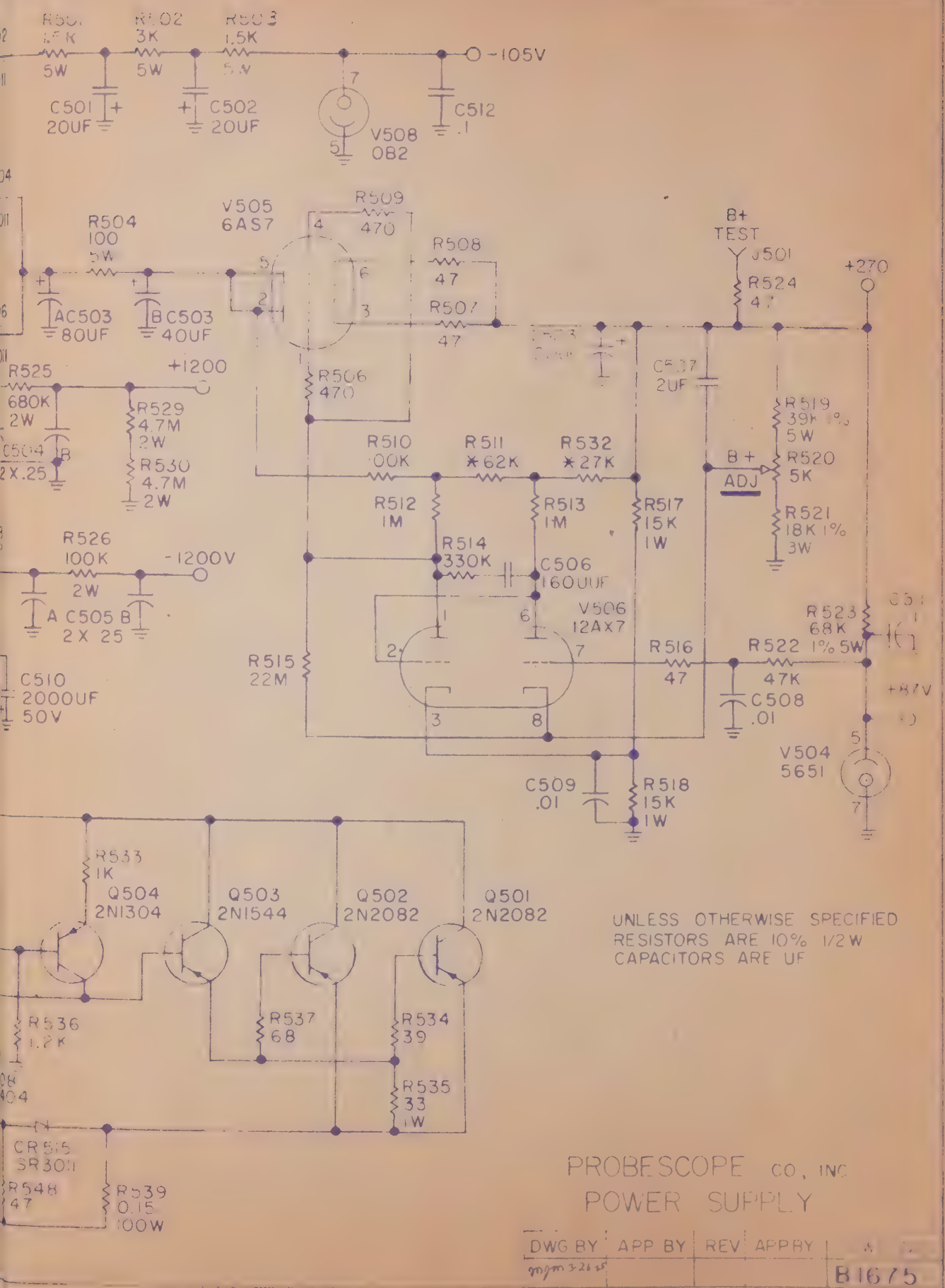

INPUT FILTER
PHASE INVERTER
MIXER
INPUT (REAR)
J103
C120 27
J101
ATTENUATOR
R109 220K 2W
C118
V103 12AY7
Z101
S01
X1
X100
X1K
X10K
INPUT
C01 45
V101 NE-2
R133 3.3M
J105
MARKER IN
R110 2K
C105A 80ufd
FIL
C104
V104 5879
GAIN
R114
R115 5.1K 5%
HAR BAL
R119 10K
MARKER LEVEL
R124 250K
R117 22K
C108 1ufd
R120 100K
R125 2.2M
C105C 20ufd
R121
C109
R118
R123 1M
C107 8
C105B 40ufd
R116 47K 1W
R126 2.2M
+270V
V105 6BH6
R131 39K
C111
R127 100K
R128 100K
C110
V106 6BH6
C113A 20ufd
R130 39K
C112
C119 .01
R139 56K 1W
R132 50K COARSE BAL
R136
Z102
C114 620
C115 180
C116 620
R137
R138 25K FINE BAL
C113B 20ufd
R140 10K
R141 8.2K
C117 1ufd
C118 20ufd
-105V
C658 750
R657 47K
R651 5K
R650 330K
R652 25K 350Ω PAD
R655 10CK 5KC SET
R654 5K 350Ω SET
C657 .2UF
V307 5636
R648 470K
R646 330K
R647 18K
C659 .01
R649 22K
C623
C622 .02
R691 33K
A-V602-B 12AX7
R695 39K
R689 5.6K
R688 560
C687 .02
C690 .02
XTAL LO
LOG SWEEP CIRCUIT
OFF ON
L301 10mh
215KC MARKER
C312
R342 560K
C313
Y301 215KC
C314 160
C309 470
R340 47K
R318 100K
C401 4700
L404
L401 10MH
R407 20K 10W
R414 25K 10W
L402 10MH
P401
J401
R129 51Ω 5%
C410
C405A 20ufd
C405B 20ufd
R406 8K 5W
R401 470K 1W
R408 12K 2W
C402 24
R402 100
V401A 1/2 6201
V401B 1/2 6201
C414 1ufd
R417 470K
C412 1ufd
R413 22K 2W
C411 .02ufd
C413 1ufd
V402A 1/2 12AT7
V402B 1/2 12AT7
R405 3K GM COMP
C403 47
R409 100 2W
R404 10K 2W
Z401
C406
C408 .01
C407
R411 24K 5%
R412 470K
C409 2400
R410 39K
R416 1.5K 2W
R415 100K
OSCILLATOR
AMP & CATH. FOLLOWER
OSC. OUT
LOG SIA CLIN
FREQ SCALE
R360 100K
R361 330K
R362 330K
R374 *
R363 100K
C360 .000
C368 27
R364 1.2M
R365 180K
C361 470
R366 2M
C362 .000
A-V308-B 12AX7
C363 250
R367 180K
C364 1000
C365 .01
C366 .01
C367 180
R368 56K
C369 390
R369 1M
R372 1.8K
R373 1.5M
C370 1.2M
C371 7-45
R371 24K
350 MARKER
54KC MARKER
A-V302-B 6072
ZERO FREQ CAL
R316 10K
R317 10K
R318 50K CENT FREQ
R315 68K 2W
V303 8242 5651
R346 15K
R319 4K 1%
R321 15K 1W
R320 4K 1%
R601 1.8M 1%
R600 1.8M 1%
R603 *
R305 2M SW MAX
R310 *
R309 5M
R311 *
SW MIN (LIN)
R313 50K
R312 2.5M
DEVIATION
SWEPT OSC CONTROL
EDGE LIGHTING
R528 50
V401 V402
V520 V519 V518 V517 V516
R527 220K
V309 NE-2
P401
V302 V306 V301 V304 V305
R524 220K
V510 NE-2
V511 NE-2
R525 220K
C510A 150 μfd.
V104 V106 V105 V107
Z101 V103 V201
V512 NE-2
R526 220K
R530 1M
C510B 50 μfd.


500KC
XTAL FILTERS
500KC
AMPLIFIERS
LOG
AMPLIFIER
DETECTOR
SCALE SELECTOR
V201 6AB4
V202 6AB4
V203 12AU6
V204 12AU6
V205 12AU6
V206 6C4
Y201 500 KC
Y202 500 KC
L204 2.4 MH
L205 2.4MH
L201 2.5 MH
L202 2.5 MH
GAIN CAL (LOG)
GAIN COMP(LIN)
SCALE S202
LB RANGE
RMS
DB
+270V
-105V
ACCESSORY SOCKET
J304
P304
V301A 1/2 12AU7
V301B 1/2 12AU7
V304A 1/2 12AX7
V304B 1/2 12AX7
V305 1/2 12AX7
V306 1/2 12AX7
A-V603-B 12AX7
BLOCKING OSC.
HOR. AMP.
VERT AMP
VIDEO FILTER
RES. ADJ.
LINE SIZE
RATE
HORIZ
SYNC
VERT
FOCUS
INT
120KC SET
HOR POS
VERT POS
ASTIG
V521 5ADP7
T502
T503
S501 POWER
OFF
P501
J502
F501 2A
F502 2A
CR510,11 2-SR3011's
CR507,8 2-SR3011's
SOME SETS USED 3 SERIES CONNECTED 319's
POWER SUPPLY
V506 12AU6
V507 6BA2/ 5651
CONTROL TUBE
V508 0B2
V509 6AS7-G
PASS TUBE
CR503 SS95HP
CR502 SS95HP
J504 B+ TEST
B+ ADJ
CR513 SR3011
CR515 SR3011
CR514 SR3011
CR516 SR3011
V514 NE 2
113V
FIL TEST
J503
S19's MAYBE USED
R516 100 25W FIL ADJ
C509A 150 µfd.
C509B 150ufd
ALL CONDENSERS BELOW 1 ARE IN µfd
ALL CONDENSERS ABOVE 1 ARE IN µµfd
RESISTORS ARE IN OHMS K KILOHMS M MEGOHMS
ALL DC VOLTAGE MEASUREMENTS MADE WITH A 20K Ω/V METER
AC VOLTAGES WITH A 5K Ω/V METER
UNLESS OTHERWISE NOTED
PROBESCOPE CO.
SCHEMATIC DIAGRAM
DWG NO
8134


INPUT FILTER
PHASE INVERTER
MIXER
CAT FOLLOW
INPUT (REAR)
J103
J101
ATTENUATOR
INPUT
X1
X10
X100
X1K
X10K
V103 12AY7
Z101
V101 NE-2
MARKER IN
J105
V104 5879
V105 6BH6
V106 6BH6
HAR BAL
MARKER LEVEL
+270V
R132 50K COARSE BAL
R136
Z102
R139 56K 1W
R138 25K FINE BAL
R140 0K
-105V
215KC MARKER
OFF
ON
L301 10mh
Y301 120KC
V401A 1/2 6201
V402A 1/2 12AT7
V402B 1/2 12AT7
V401B 1/2 6201
R405 3k GM COMP
R404 10K 2W
OSCILLATOR
AMP & CATH. FOLLOWER
OSC. OUT
LOG
SIA
LIN
R657 4.7K
R651 56K
R652 25K PAD
R655 10K 5KC SET
R654 5K 350Ω SET
V307 6606
LOG SWEEP CIRCUIT
XTAL LO
FREQ SCALE
-105V
ZERO FREQ CAL
A-V302-B 6072
V303 8AA2 5651
R316 10K
R317 10K
R318 50K CENT FREQ
R346 15K
R315 68K 2W
R319 4K 1%
R320 4K 1%
R321 15K 1W
R601 1.8M 1%
R600 1.8M 1%
R603
R305 2M SW MAX
R310
R309 5M
R311
SW MIN (LIN)
R313 50K
R312 2.5M
DEVIATION
SWEPT OSC CONTROL
A-V308-B 12AX7
350Ω MARKER
54KC MARKER
EDGE LIGHTING
R530 1M
R526 220K


500KC
XTAL FILTERS
500KC
AMPLIFIERS
AMPLIFIER
DETECTOR
SCALE SELECTOR
V201 6AB4
V202 6AB4
V203 12AU6
V204 12AU6
V205 12AU6
V206 6C4
Z201
Z202
Z203
Y201
Y202
500 KC
L201 2.5 MH
L204 2.4MH
L205 2.4MH
L202 2.5 MH
S2A
S2B
GAIN CAL (LOG)
GAIN COMP(LIN)
SCALE S202
RMS
DB RANGE
+270V
-105V
ACCESSORY SOCKET
J304
P304
V301A 1/2 12AU7
V301B 1/2 12AU7
V304A 1/2 12AX7
V304B 1/2 12AX7
V305 1/2 12AX7
V603-B 12AX7
BLOCKING OSC
HOR. AMP.
VERT. AMP
VIDEO FILTER
S301
ASTIG
FOCUS
V521 5ADP7
J301 HORIZ
J302 SYNC
J303 VERT
T301
T302
T303
P302
J302
S501 POWER
F501 2A
F502 2A
POWER SUPPLY
PASS TUBE
V506 6AS7-G
V508 12AU6
V507 6SA2/ 5651
CONTROL TUBE
CR510,11 2-SR3011's
CR507,8 2-SR3011's
CR513 CR515 CR514 CR516 SR3011
SOME SETS USED 3 SERIES CONNECTED S19's
S19's MAYBE USED
V514 NE-2
113V
FIL TEST
J503
R516 100 25W FIL ADJ
B+ ADJ
B+ TEST
J504
CR503 SS95HP
CR502 SS95HP
R503 680K 2W
R502 4.7M 2W
R635 4.7M 2W
R537 68 5%
C502A 25ufd 2000V
C502B 25ufd 2000V
C503A 25ufd 2000V
C503B 25ufd 2000V
C509A 150 ufd.
C1098 150ufd
C503 20ufd.
C508 20ufd
R136 R137
R111 R112
R212 R218
R221 R223
R224 R227
R231
C106 C229
C407
PROBESCOPE CO.
SCHEMATIC DIAGRAM
REV A
DWG BY MJM
APP BY
DWG NO B1342
DATE 5-7-64
DATE 4-22-64
ALL CONDENSERS BELOW 1 ARE IN ufd
ALL CONDENSERS ABOVE 1 ARE IN uufd
RESISTORS ARE IN OHMS K KILOHMS M MEGOHMS
ALL DC VOLTAGE MEASUREMENTS MADE WITH A 20K Ω/V METER
AC VOLTAGES WITH A 5K Ω/V METER UNLESS OTHERWISE NOTED

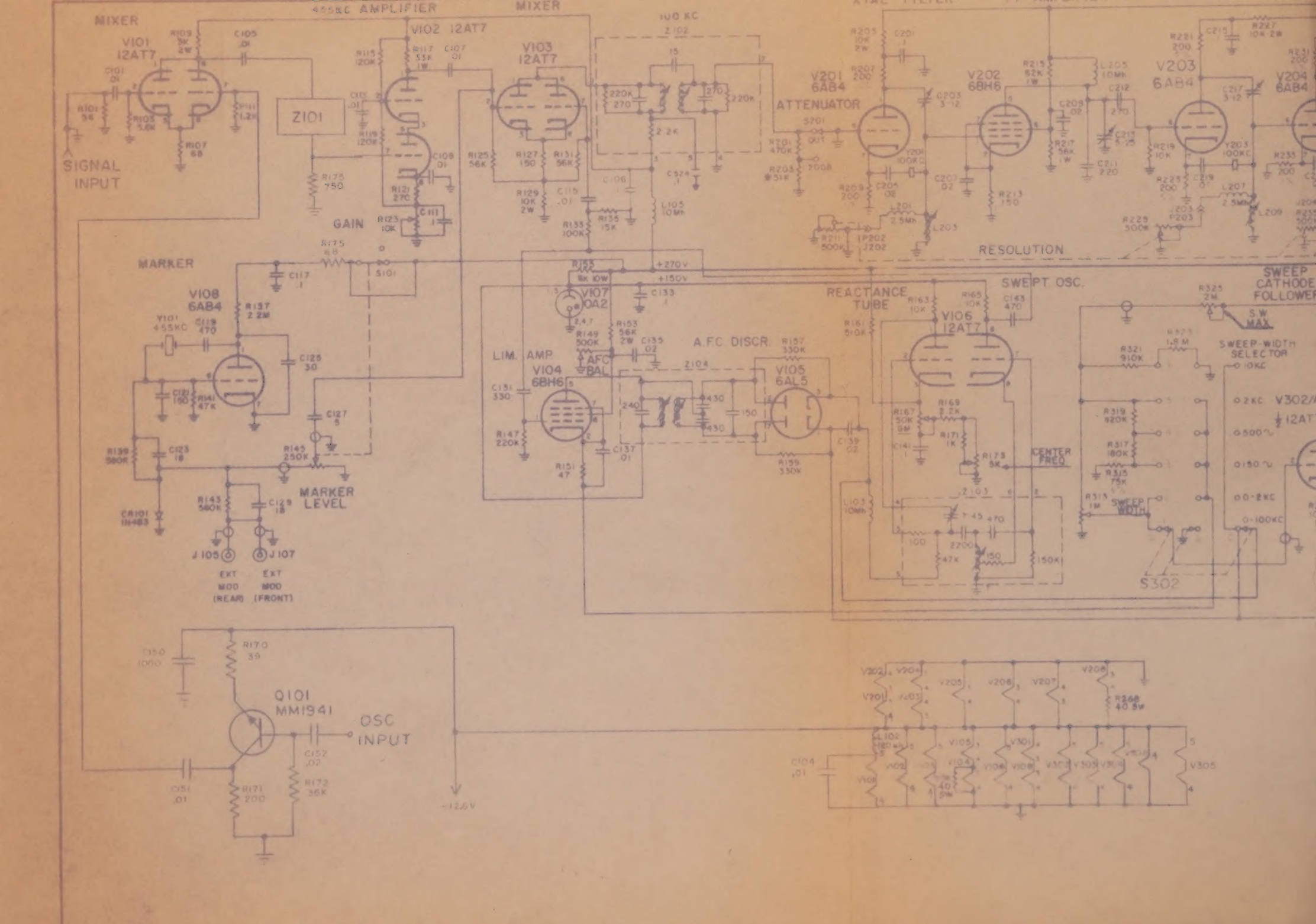

CR501
SR3011
325V AC
T501
CR503
SR3011
P502
F501
3ASB
OFF
POWER
2
4
5
6
1
CR505
SR30
1250V AC
6.3V AC
R531
50
EDGE LIGHTING
12
7
8
13
DS501
DS502
DS503
DS504
14
9
10
35V CT
6A
CR513
MR322
CR512
MR322
CR512
SR3011
CR513
SR3011
CR517
SZ5.6
Q505
2N404
Q506
2N404
Q507
2N404
R538
330
R543
56K
R242
680
R546
500
R544
470
R545
820
-12VADJ
-12V
J503
FIL TEST
CR518
SZ3.3
C513
.01
R541
820
R540
56K

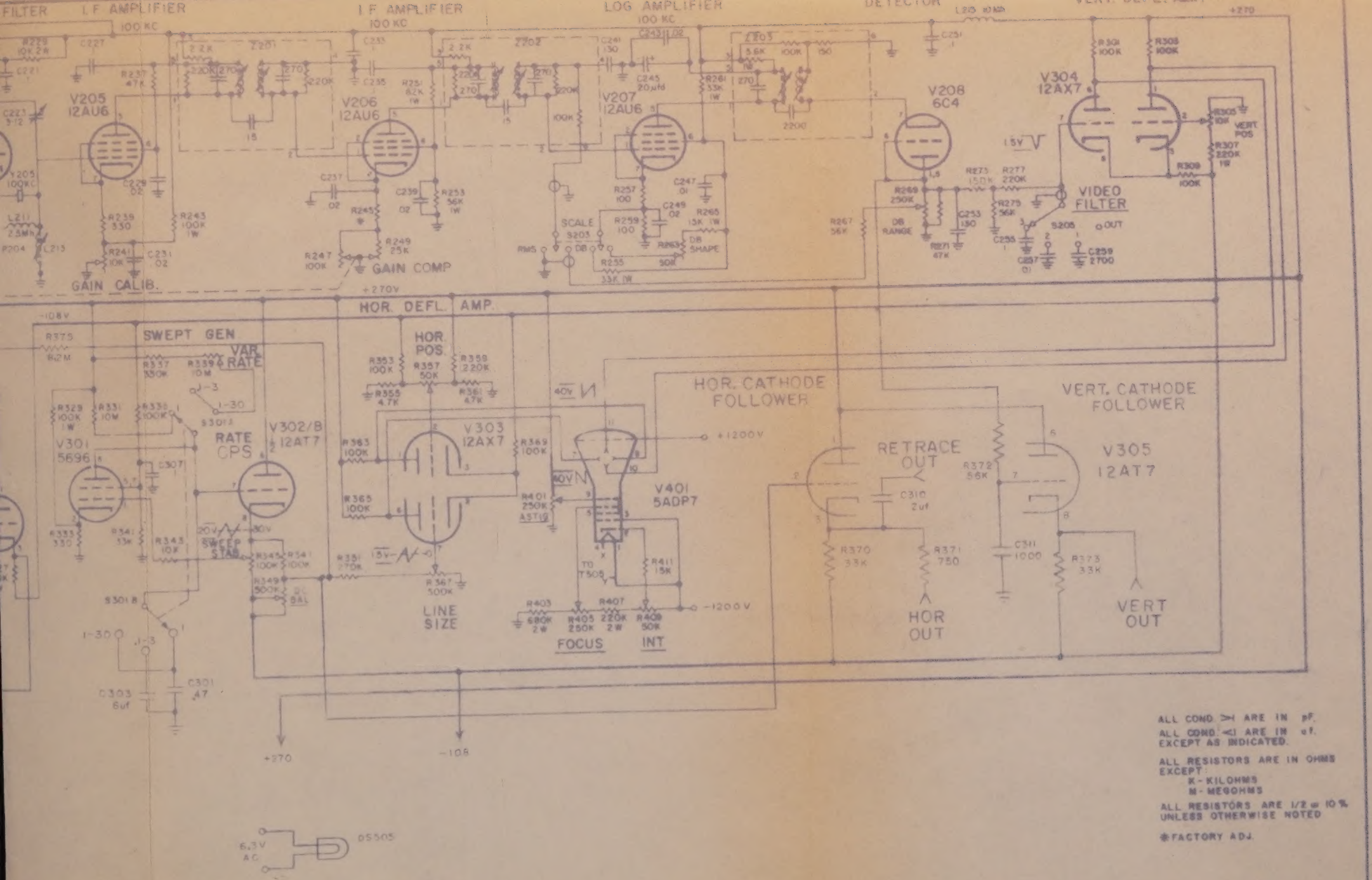


UNLESS OTHERWISE SPECIFIED
RESISTORS ARE 10% 1/2W
CAPACITORS ARE UF

PROBESCOPE CO., INC
POWER SUPPLY

DWG BY	APP BY	REV	APP BY	
mjm 3-26-65				B1675


MIXER
455KC AMPLIFIER
MIXER
100 KC
Z102
V101 12AT7
V102 12AT7
V103 12AT7
V201 6AB4
ATTENUATOR
V202 6BH6
V203 6AB4
V204 6AB4
SIGNAL INPUT
Z101
GAIN
MARKER
RESOLUTION
V108 6AB4
Y101 455KC
S101
+270V
+150V
V107 0A2
REACTANCE TUBE
SWEPT OSC.
SWEEP CATHODE FOLLOWER
LIM. AMP
V104 6BH6
AFC BAL
A.F.C. DISCR.
V105 6AL5
V106 12AT7
S.W. MAX
SWEEP-WIDTH SELECTOR
CENTER FREQ
MARKER LEVEL
J 105
J 107
EXT MOD (REAR)
EXT MOD (FRONT)
S302
V302 1/2 12AT
Q101 MM1941
OSC INPUT
-12.6V



ALL COND. >1 ARE IN pF.
ALL COND. <1 ARE IN µf.
EXCEPT AS INDICATED.

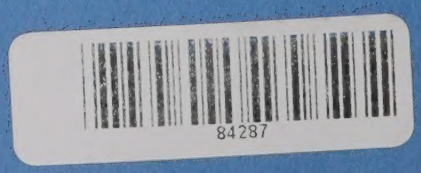
ALL RESISTORS ARE IN OHMS EXCEPT:
K - KILOHMS
M - MEGOHMS

ALL RESISTORS ARE 1/2 w 10 % UNLESS OTHERWISE NOTED

*FACTORY ADJ.

SPECIAL FOR SYLVANIA

PROBESCOPE CO. INC.			
MD 500 SCHEMATIC DIAGRAM			
	DWG BY	APP BY	DWG NO
	D. M.		E1817
	DATE	DATE	
	2-4-65		


84287